United States Circuit Court
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH COMPANY,
Complainant,
vs.
AMERICAN GRAPHOPHONE COMPANY,
Defendant.
In Equity on Letters Patent No. 683,615.

NATIONAL PHONOGRAPH COMPANY,
Complainant,
vs.
AMERICAN GRAPHOPHONE COMPANY,
Defendant.
In Equity on Letters Patent No. 683,676.

NEW JERSEY PATENT COMPANY,
Complainant,
vs.
AMERICAN GRAPHOPHONE COMPANY,
Defendant.
In Equity on Letters Patent No. 831,668.

Complainants' Paper Exhibits

PRICE, SMITH, SPILMAN AND CLAY,
Solicitors for Complainants.

FRANK L. DYER,
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Of Counsel for Complainants.

PHILIP MAURO,
C. A. L. MASSIE,
Solicitors and of Counsel for Defendant.

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United States Circuit Court

SOUTHERN DISTRICT OF WEST VIRGINIA.

NEW JERSEY PATENT COMPANY,
Complainant.
vs.
AMERICAN GRAPHOPHONE COMPANY,
Defendant.

In Equity on
Joyce Patent
No. 831668.

Complainants' Exhibit—McCoy Report.

Bridgeport, Conn., Nov. 28th, 1906.

Visit to the American Graphophone Company's factory with L. H. Bassett, of Bridgeport, Conn.

Mr. Ray, Superintendent of the factory, furnished us with a guide to the different departments.

I was interested in the cylinder record department, and our guide informed us that they were not rushed with their cylinder records now, as their rush was about over on cylinder records.

They have a number of wax tanks in the cylinder record department.

They have large round wax tanks at which four men can work at one time dipping or moulding. At the tank that we were watching the men moulding they were moulding the six inch cylinder records.

We were informed that about one-half of the records that was moulded would turn out good and the other half would have to be remoulded again.

If the required degree of heat was not kept in the tanks at all times, the moulding process would turn out bad.

They have a rack which holds eight moulds, and the rack is attached to a hook over the wax tank, which hook is operated by machinery, and the racks with the mould on are let down in the molten wax, which flows into the moulds; the moulds are left in the molten wax for nearly two minutes, a gong is sounded and all the moulds are raised out of the tanks at the same time. The racks with the moulds on are put into a tank of water for to cool; after they are cooled off the core is taken out, and the record is reamed out and put on a rack, and the white powder is put on the ends of the record for to show the name of the record.

I was informed that they had a duplicate moulding plant, the same as the department that we were in, in another building, which they could put in operation in cases of an emergency, or if they had a big rush order for cylinder records, or in case of fire or accident to their present moulding plant; the other plant he said was not running now, as their rush for cylinder records was all over for this season.

I was inquiring from the guide about the number of people that was employed in the factory at the present time; he said that there was nearly 1,500 employed now. We went in all the other departments. It looked as though there was something doing in the disc record department as they were all rushing with work there.

In the cylinder department things looked very quiet there, no one rushing.

McCOY.

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY,
} In Equity on Letters Patent No. 683,615.

NATIONAL PHONOGRAPH COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY,
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NEW JERSEY PATENT COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY,
} In Equity on Letters Patent No. 831,668.

Complainants' Exhibit—Certified Copy of Defendant's Affidavits in its Suit against Walcutt & Leeds.

Affidavit of EDWARD D. EASTON, for use in suit about to be brought in U. S. Circuit Court, Southern District of New York, by American Graphophone Company against Walcutt & Leeds, Ltd., et al.

AMERICAN GRAPHOPHONE COMPANY,
Complainant,
vs.
WALCUTT & LEEDS, LIMITED, ET AL.,
Defendants.
} In Equity.

STATE AND COUNTY OF NEW YORK, *SS:*

EDWARD D. EASTON, being duly sworn, says:
I am President and General Manager of the American Graphophone Company, complainant herein. I have been engaged in the talking-machine business since the beginning thereof, and am familiar with the past and present conditions of that business in all its details.

The defendant, Cleveland Walcutt, and the firm of Walcutt & Leeds, his successors in business, have for about five years past carried on in this city the manufacture of sound records, using the ordinary graphophones or phonographs and blank tablets in the well-known manner. Some of the phonographs in use by them were purchased by Walcutt from the receiver of the North American Phonograph Company, and it is likely that some, or probably all, were made under license from complainant. Some phonographs and supplies were made and sold by said receiver without authority from complainant, and, in consequence thereof, complainant brought suit against him in the Circuit Court for the District of New Jersey, resulting in a final decree for complainant, entered August 24, 1896, for an injunction and for damages and costs, which were recovered by complainant.

Several years ago, in order to reduce the cost of sound-records to users thereof, complainant began the manufacture of "duplicate" sound-records under the patent in suit and other patents owned by complainant. This manufacture is a different and distinct operation from the production of "original" sound-records, the latter being merely the normal product of the graphophone. Duplicate sound-records are made on duplicating machines, especially constructed for that work, and their function is to produce on a blank tablet an engraved copy of the sound-writing on an original "master" record, the copying being effected by transferring devices. Complainant has a large number of these machines in operation at its factory. It has never sold any duplicating machines to others, or licensed or authorized any person or concern to make and sell such machines. With the exception of a shop-right license granted in February, 1898, to Mr. Edison's Company to make duplicates at one shop only, it has granted no license or authority to any one to manufacture such articles. Duplicate sound-records cannot be made except on duplicating machines, and particularly cannot be made by graphophones or phonographs. Although theoretically two graphophones could be so placed that one (provided with a sound-record and a reproducer) could talk into another (provided with a blank tablet and recorder), it would not be possible to make commercial duplicates in that way.

During all this time when complainant was introducing duplicate sound-records commercially, defendants did not enter upon that business, but used their graphophones and phonographs for making original sound-records until the latter part of the year 1896, about a month before the bill of complaint in the action above mentioned was filed. As late as May, 1897, the catalogues printed by Walcutt & Leeds, one of which was produced by the witness Alward in suit No. 6542 against the defendants, Walcutt & Leeds, herein, and obtained by him at their place of business on May 14, 1897, contained this statement:

"We do not make a few original records to improve the average, and sell the majority of duplicates. We make and sell original records only. This is guaranteed."

I have recently obtained possession of a catalogue which bears on the first page of the cover the following title: "Records for the Phonograph and the Graphophone; Made for the Consolidated Phonograph Companies. Sold by Walcutt & Leeds, Ltd., 53 East Eleventh Street, New York."

This was the first intimation I had that the firm of Walcutt & Leeds had been converted into a corporation. I received the first positive confirmation of this on February 25, 1898.

There are known at the present time duplicating machines of two types, which differ in form, though not in substance. The first of these is that described by the Tainter Patent No. 341,287, May 4, 1886, and consists essentially of supports for the master record and blank tablet respectively, means

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for rotating these supports synchronously, a follower for following the sound groove of the master record and receiving vibrations therefrom, and a cutting point mechanically connected with said follower, for cutting a copy of the original record in the blank tablet. This type of machine has been improved by Bettini (See Patent No. 488,381, dated December 20, 1892) and Macdonald (Patent No. 559,806, dated May 12, 1896). The Tainter, Bettini and Macdonald patents are all owned by the complainant company. This type is that which is used by complainant and by all others who are making duplicate records at the present time, so far as my information extends.

The second type, which is the same in principle as the first, differs therefrom in that the follower and cutting point actuated thereby are each carried by a diaphragm, and the two diaphragms are connected by a closed passage in which a body of air or other fluid is confined. This type of machine is covered by patent No. 475,490, granted to me, as the assignee of L. F. Douglass, May 24, 1892, and by me assigned to the complainant company. The duplicate records produced by this machine are not of so good a quality as those produced by duplicating machines of the type just described.

No other duplicating methods or machines have ever been commercially used to my knowledge, and my knowledge of the industry is such that I am sure I would have learned thereof if any other method or machine existed. Duplicating machines cannot be used for any purpose except to make sound records (copies of originals), such as described and claimed in the patent in suit. The cost of making original records (which are made on graphophones or phonographs in the well-known way) is relatively high, but by means of duplicating machines, using an original record so made as a "master," duplicates thereof can be obtained at a much smaller cost. By the employment of duplicating machines, complainant is enabled to sell duplicate sound-records at twenty-five cents apiece wholesale.

Duplicating machines are of simple construction and of small dimensions. Fifty such machines can operate in a room of moderate size and turn out a product of about five thousand a day.

I have been informed by Mervin E. Lyle, and by several other persons, as coming directly from Walcutt, that, since December 10, 1897, the date on which said Walcutt says the business of Walcutt & Leeds was transferred to the corporation of Walcutt & Leeds, Limited, and since the recent decrees against Walcutt & Leeds, a great many additional duplicating machines have been added to the plant at No. 53 East Eleventh Street, and that the daily output of that plant amounts to many thousands.

Said Walcutt is also inducing and inciting others to infringe by spreading the statement that no decree has been made against his firm in respect to duplicate sound-records, and this statement has appeared in print and has been extensively circulated.

By reason of this fact, complainant has sustained, and is sustaining, great and irreparable injury, for which no adequate damages can possibly be recovered. The only persons openly connected with the corporation of Walcutt & Leeds, Limited, who have any substantial interest therein, are said Walcutt and Leeds, who have no responsibility or financial standing. The other three directors, who, Mr. Walcutt says, represent this controlling interest, and which he refuses to disclose, are clerks in the office of Mr. Hayes, of Newark, who has for many years been, and is now, attorney for George E. Tewksbury, who is well known to be actively associated with Walcutt and Leeds, and is defendant in suits brought by this complainant in the District of New Jersey. These three directors are understood to have only a nominal interest in the defendant corporation and are persons of no financial standing. On information and belief I assert that the controlling interest in said corporation is owned by said Tewksbury; that he dictates the policy of said corporation, and that the officers of said corporation, the said Walcutt and Leeds, while nominally carrying on the business of said concern, in fact do so under the directions of the said Tewksbury.

EDWARD D. EASTON.

Sworn to and subscribed before me
this 28th day of February, 1898. }

S. O. EDMONDS,

(SEAL) Notary Public, Kings Co.
Certificate filed in New York Co.

(Attached to the foregoing affidavit of Edward D. Easton are copies of the following Letters Patent: No. 341,214 to Bell & Tainter of May 4, 1886; No. 341,287 to S. Tainter of May 4, 1886; No. 488,381 to G. Bettini of Dec. 20, 1882, and No. 559,806 to T. H. Macdonald of May 12, 1896.)

Affidavit of C. A. L. MASSIE, for use in suit about to be brought in the United States Circuit Court for the Southern District of New York, by American Graphophone Company against Walcutt & Leeds, Ltd., et al.

CIRCUIT COURT OF THE UNITED STATES,

For the Southern District of New York.

AMERICAN GRAPHOPHONE COMPANY,
Complainant,
vs.
WALCUTT & LEEDS, LIMITED, ET AL.,
Defendant.
} In Equity.

STATE AND COUNTY OF NEW YORK,
SOUTHERN DISTRICT OF NEW YORK
} *SS:*

AFFIDAVIT OF C. A. L. MASSIE.

C. A. L. MASSIE, being duly sworn, deposes and says:

I am a resident of the City of New York, and an attorney at law with the firm of Pollok & Mauro, counsel for complainant in this case.

I have devoted much time to the study of former suits brought by the complainant, one against Cleveland Walcutt, and two against Walcutt & Leeds (both Mr. Walcutt and Mr. Leeds being defendants in the present suit), and I am familiar with the evidence in those suits.

Mr. Cleveland Walcutt, one of the defendants herein, testified in his own behalf, as follows:

"In making the original records I never have, nor do not now, use anything but the Edison Phonographs purchased by me from the receiver of the North American Phonograph Company.

"In making duplicate records I use the same machines. They are arranged in pairs, one machine carrying an original or master record, and the other machine a blank cylinder. The only thing used in addition to the machine as originally built and furnished by the Edison Phonograph Works is a simple mechanical appliance for connecting the sound apparatus of the two machines used to each other, so that the record may be reproduced on the blank cylinder; batteries for running machines and tables or benches, to place them on for convenience. The mechanical appliance used to connect the two machines together is a secret invention of my own, although the invention consists more of the actual method of attaching the appliance than in the form of the appliance itself. These appliances for connecting the two machines together I purchased from the Edison Phonograph Works, or, rather, from the National Phonograph Company, which is the selling company for the Edison Phonographs and supplies. The appliances were made for me by the National Phonograph Company, expressly to be used for this purpose; that is, to connect two phonographs together, so that they could be used to make duplicate records, or to transfer the record cut in one cylinder, placed on one of the machines, to a blank cylinder placed on the other machine. With the exception of this mechanical appliance, there is absolutely nothing added to the machines as they were originally made and furnished to the North American Phonograph Company. In the machine on which the record is placed I do not use the recording stylus, nor in the machine on which the blank cylinder is placed do I use the reproducing stylus. On neither of the machines do I use the hearing tubes, speaking tubes, shaving-off apparatus, body boxes, nor any other minor parts of the machines, which, although they would do no harm, and could be left on the machines, are still unnecessary, and might be in the way."

(Defendants' Printed Record, *A. G. Co.* vs. *W. & L.*, No. 6542, pp. 16-18.)

And again:

"By referring to my books, I find that the first bill made for duplicate records representing the first sale of duplicate records made by my firm was dated November 20, 1896."

(Defendants' Printed Record, *A. G. Co.* vs. *W. & L.*, No. 6542, p. 26.)

MR. WALCUTT, called as a witness for complainant in one of these cases, testified as follows:

Q. 3. What business are you now engaged in?

A. The phonograph record business.

Q. 4. Alone?

A. No.

Q. 5. Who is with you?

A. I am the treasurer of the corporation.

Q. 6. Of what name?

A. Walcutt & Leeds, Limited.

Q. 7. Who are the other officers of that company?

A. E. F. Leeds, President; I am the secretary and treasurer.

Q. 8. Did that company succeed to the business carried on by the firm of Walcutt & Leeds of which you are a member?

A. Yes.

Q. 9. When?

A. About December 10th, last.

Q. 10. What do you mean when you say that you are in the phonograph record business; what does this include, in other words?

A. Making phonograph records.

Q. 11. Are you now engaged in making master records?

A. No.

Q. 12. Do you make duplicates?

A. Yes.

Q. 14. Your concern also sells these duplicates that it makes?

A. Yes.

Q. 15. How long has the company been making duplicates?

A. From about December 10th.

Q. 16. Continuously?

A. Yes.

Q. 17. Are you a stockholder in the Walcutt & Leeds Company?

A. Yes.

Q. 18. Is Mr. Leeds?

A. Yes.

Q. 29. Did the Walcutt & Leeds Company, in succeeding to the firm of Walcutt & Leeds, acquire the plant and sound recording and reproducing instrumentalities, etc., belonging to the latter concern?

A. Yes.

Q. 30. This apparatus was left in the store that had been occupied by Walcutt & Leeds?

A. Yes.

Q. 32. Was any change made in the employees or in the methods of conducting the business due to the corporation's succession to the partnership?

A. Some minor change, possibly.

Q. 33. I call your attention to complainant's Exhibit Defendant's Sound Record No. 2, being one of the exhibits introduced in the action between the same parties that are interested in this suit for infringement of Tainer Patent No. 341,214. In what respect do the sound records which your concern is making and selling, and has been making and selling since December 10, 1897, differ from the exhibit before you?

A. I don't know that they differ in any respect.

Q. 39. When the firm of Walcutt & Leeds was succeeded by the Walcutt & Leeds Company, I understand that the latter concern took everything which the partnership had in the way of plant, accessories, etc., and took therefore the machines which you had in mind when describing the work done by the partnership. Is that true?

A. The company at the time of the transfer above, December 10, 1897, took everything in the way of machines which the firm had at that time.

Q. 40. Did the company take the mechanism necessary to enable it to carry out the process of duplicating?

A. Yes.

Q. 44. In October, 1897, you occupied the premises in 11th street now occupied by the Walcutt & Leeds Company, did you not?

A. Yes.

Q. 45. Prior to December 10th had any of the record-making or duplicating apparatus been removed from that place of business?

A. I think not.

Q. 46. You would know if it had been, would you not?

A. Unless it was some very minor part of it.

Q. 47. Is that apparatus at that place now?

A. Everything that was not removed must be there.

Q. 47. The question before was, between October 12th and December 10th. I now ask you if that apparatus is there now?

A. Nothing has been removed since December 10th, except some very minor parts. We might have sold a belt of a machine or a screw or something of that kind.

Q. 48. You are the active manager of the Walcutt & Leeds Company, are you not?

A. Nominally.

Q. 49. What do you mean by that?

A. I don't control the corporation, if that is what you mean.

Q. 50. But you have the active management of its business, its record making and selling?

A. Nominally; as a matter of fact, I am under the control of the controlling interests of the company.

Q. 51. Do you direct the duplicating or selling or other business of the company?

A. Yes.

Q. 52. I again call your attention to the deposition in suit on Patent No. 341,214, and particularly to such parts of it as deal with the process or the apparatus employed by you at the time of that deposition for duplicating sound records; please say whether or not this testimony stands to-day as descriptive of the process and instrumentalities used by the Walcutt & Leeds Company?

A. I decline to answer; I think the question is the same as the ones I declined to answer before.

Q. 53. Did the Walcutt & Leeds Company acquire from the firm of Walcutt & Leeds the "simple mechanical appliances" with which that firm connected its phonographs for duplicating records?

A. Yes.

Q. 72. How long have you been familiar with that process and that arrangement of the Edison phonographs and your appliances which you used in or prior to October, 1897?

A. I think since about December, 1896. I am not sure absolutely about that date; earlier than that, I guess it was.

Q. 74. You probably tried a number of methods of utilizing Edison phonographs for making duplicates, and determined that this was the best?

A. No; I never tried any way but this.

(Typewritten copy of testimony taken before John A. Shields, Esq., Wed., Feb. 23, 1898, in *A. G. Co.* vs. *W. & L.,* No. 6541.)

On or about January 19, 1898, in case 6542 (on Patent No. 341,214, a decree was entered against Walcutt & Leeds, granting a perpetual injunction and referring the case to a master to report an account of damages and profits. Pursuant to this decree, Mr. Walcutt was subpoenaed on behalf of complainant on February 25, 1898, and testified before the master, Henry G. Ward, Esq., as follows:

Q. 4. What is your connection with the corporation known as Walcutt & Leeds, Limited?

A. I am secretary and treasurer.

Q. 5. What is the connection of Mr. Leeds?

A. He is the president.

Q. 6. What other officer is there; any?

A. None other.

Q. 22. That concern, as I understand it, took from you the apparatus which you had prior to December 10th, and which was operated by the partnership of Walcutt & Leeds for making duplicate records; and took over the place of business operated by Walcutt & Leeds, retained its employees, etc. Am I correct?

A. Yes.

Q. 36. You inaugurated the bookkeeping system of Walcutt & Leeds?

A. Yes.

Q. 41. Where are those books now?

A. They are not in existence.

Q. 42. When did you see them last?

A. I think shortly after the tenth of December.

Q. 43. Under what circumstances?

A. We destroyed them at that time.

Q. 44. Burned them?

A. Yes.

Q. 45. All of them?

A. Yes.

Q. 55. Who was present at the time they were destroyed beside yourself?

A. Mr. Leeds.

A. Only, yes.

Q. 59. What did you do with these mail orders?

A. They were all destroyed with the books.

Q. 61. What about written orders other than mail orders?

A. They all went, too.

Q. 62. The bills?

A. The same thing; they were all filed together in the letter files.

(Typewritten copy of testimony taken before Henry G. Ward, Esq., February 25, 1898, in the case of *A. G. Co.* vs. *W. & L.,* No. 6542.)

During the course of this last hearing, Mr. Walcutt said (while arguing the propriety of replying to a question put to him) that the corporation of Walcutt & Leeds was using the machines and appliances received from the firm of Walcutt & Leeds in their business of making duplicates; but he contended that whatever the corporation did was not before the master, as the corporation was not a party to that suit. For the reason above mentioned the statement of Mr. Walcutt was not included in the stenographer's record. The admission was made in the presence of the master, Mr. S. O. Edmonds, Mr. Philip Mauro and myself.

Some time after the decree against Walcutt & Leeds in case No. 6542 complainant brought proceedings for attachment for contempt, which proceedings are as yet undisposed of. I have read the papers in the motion, and, among others, are affidavits of Philip Mauro and Shelton T. Cameron, both of Washington, D. C., verified February 4th and 5th, respectively, 1898. True copies of these two affidavits are annexed hereto and made a part of this affidavit.

And further this affiant saith not.

C. A. L. MASSIE.

this 28th day of February, 1898. }
Subscribed and sworn before me }
S. O. EDMONDS,

(SEAL.) Notary Public Kings Co.
Certificate filed in New York Co.
A True Copy. C. A. L. M.

IN THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

AMERICAN GRAPHOPHONE COMPAN
Complainant,
vs.
CLEVELAND WALCUTT AND EDWARD F. LEEDS.
} In Equity.

STATE OF NEW YORK, }
COUNTY OF NEW YORK, } SS.

PHILIP MAURO, being duly sworn, says:

I reside in Washington, D. C., and am of counsel for the complainant herein. I have participated in and am familiar with all the litigation on the graphophone patents.

On or about February 6th, 1897, two suits were begun against Walcutt & Leeds, the defendants herein, one under Patent No. 341,214, of May 4, 1886 (the present suit), the other under Patent No. 341,287 of the same date. The infringement charged

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in the first suit was the manufacture, use and sale of duplicate sound records, that is to say, of engraved copies of original sound records, the originals being made on the graphophone (or phonograph). The infringement charged in the second suit was the use, for the purpose of making duplicates, of duplicating machines substantially as described in the patent in suit. Defendants tried to maintain secrecy as to the construction of their duplicating machines, and having ignored interrogatories annexed to the bill of complaint, exceptions for insufficiency were filed to their answer, and were argued in June, 1897. They were allowed by the Court in January, 1898.

Meanwhile defendant Walcutt was subpoenaed and examined by complainant, in the suit on Patent No. 341,214, and also testified in that case on his own behalf. Regarding his duplicating machines, he claimed (1) that they were ordinary phonographs purchased by him from the receiver of the North American Phonograph Company; (2) that the only thing in addition to these phonographs that he used in making duplicates was a "simple mechanical device" contrived by himself; (3) that his method of making duplicates was a secret invention of his own.

This case went to final hearing before Judge WHEELER, who sustained the patent and held that defendants had infringed it.

On Saturday, January 22nd, 1898, an argument was had before Judge WHEELER, touching the settlement of the decree, at which Mr. C. A. L. Massie, Mr. H. T. Kingsbury and myself were present on behalf of the complainant. Mr. West, Mr. Walcutt in person and a Mr. Tewksbury, who is a defendant in suits pending in New Jersey, were also present. Mr. West contended that his clients had the right to use any graphophone or phonographs in his possession and which were licensed under the patent in suit, for making duplicates, and he stated to Judge Wheeler that his clients made duplicates by placing two phonographs close together and permitting one phonograph to talk into the other, so that the listening phonograph received a copy of the record on the talking phonograph. My contention was that duplicates could not be made in this way; that defendants did not so make them, but used regular duplicating machines, and that none of their sound records were products of licensed phonographs or graphophones. Defendant Walcutt's testimony shows that he does not make duplicates in this way. In order not to have the decree so drawn as to interfere with the legitimate use by defendants of licensed machines lawfully in their possession, Judge Wheeler interlined in the decree (as drawn by me) these words: "Made on machines not procured from the plaintiff or under this patent," the whole passage then reading: "that the defendants be enjoined particularly from the manufacture, use and sale of the 'duplicate' sound records made on machines not procured from the plaintiff or under this patent"; and Judge Wheeler remarked that it would appear by the accounting how many (if any) duplicates had been made by defendants on machines bought from complainant or licensed under the patent in suit. I agreed to this interlineation, knowing that complainant had never sold any duplicating machines or licensed their use by any one. A copy of the decree is hereto annexed marked "Exhibit A."

Immediately after the settlement of the decree Mr. West called to see me at the office of Messrs. Lee & Lee, 20 Nassau street, and a conversation ensued in the presence of Mr. Massie. Mr. West stated that it was the wish of his client to make an agreement with the American Graphophone Company. I told Mr. West that this was a business matter to be settled between the parties concerned, but that I did not think my client would consider at present any proposition to grant Walcutt & Leeds a license to manufacture duplicates. Thereupon Mr. West stated that his clients intended, anyhow, to continue making duplicates, and that the decree as drawn by Judge WHEELER permitted it. I asked Mr. West if he meant to say that his clients would continue, as they had been doing, to use their mechanical duplicating machines. He replied that such was his meaning, and that he had advised them that they had the right to do so. I asked him, if that was the case, why he asked a license from the American Graphophone Company, to which he made no reply.

(Signed by) PHILIP MAURO.

Sworn to and subscribed before me
this 4th day of February, 1898.

ELISHA K. CAMP,

(SEAL.) Notary Public, New York Co.
(A true copy.) C. A. L. M.

UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF NEW YORK.

AMERICAN GRAPHOPHONE CO.
vs.
CLEVELAND WALCUTT AND
EDWARD F. LEEDS.
In Equity.

AFFIDAVIT OF SHELTON T. CAMERON.

STATE OF NEW YORK, }
CITY OF NEW YORK, } ss.

SHELTON T. CAMERON, being duly sworn, says:

I reside in Washington, D. C., and am a solicitor of patents and expert in patent causes. I am familiar with the construction and operation of talking machines, commonly called graphophones and phonographs, and have repeatedly examined and operated such machines.

I am familiar with United States Patent No. 341,214, granted to Chichester A. Bell and Sumner Tainter, and the construction and operation of the devices described and claimed therein. I am also familiar with the construction and operation of apparatus for duplicating graphophone records, especially apparatus of the character defined in U. S. Patent to Sumner Tainter, No. 341,287, as the same has been improved by Gianni Bettini in the manner shown in his U. S. Patent No. 488,381, and perfected by Thomas H. Macdonald in the form defined by U. S. Patent No. 559,806.

I have recently given an expert deposition in this cause. I have carefully read the several depositions given by Cleveland Walcutt, one of the defendants in this cause, and also his depositions given in the case of American Graphophone Company vs. Cleveland Walcutt, which was a suit for the infringement of the same Bell and Tainter Patent No. 341,214, and the Tainter Patent No. 341,288.

As I have pointed out in my expert deposition above referred to, the sound record defined in claims 7, 8, 10, 17 and 18 of the Bell and Tainter Patent No. 341,214, consists of a tablet or solid body of wax or waxlike composition having narrow lines, of irregular form, corresponding to sound waves, cut or engraved upon its surface, the lines, or grooves, constituting the record having sloping side walls.

These records may be the product of the graphophone or they may be the result of the operation of other apparatus different from the graphophone.

The records made by a graphophone are known in the art as "original" records, being formed by causing the sound waves as they proceed from their usual and natural sources to impinge upon the diaphragm of the recorder on the graphophone. All other records are known as "duplicate" records, and in the formation of such "duplicates" it is absolutely essential that an "original" be employed as a pattern or "master," acting in connection with the duplicating apparatus.

Several forms of duplicating apparatus have been proposed, but I know of only one form that is in practical commercial operation to-day. In this apparatus means are provided for simultaneously revolving the "original" record which is to act as the pattern or "master" and a blank tablet upon which it is desired to cut the "duplicate" record. A rubbing point similar to or the same as the reproducing style of a graphophone is caused to track in the groove constituting the "original" or "master" record, while a cutting style, similar to or the same as the recording style of a graphophone, has its point imbedded in the surface of the blank tablet. The rubbing style which acts on the master record is connected by a suitable mechanical appliance, as a lever, with the graving or cutting style which acts on the blank tablet. The two styles and their connecting lever are provided with a carriage which is given a transitory movement lengthwise of the tablets, by means of a feed screw arranged parallel with the tablets. Means are also provided for automatically maintaining the styles in proper operative relation to the master record and the blank tablet respectively.

When the "master" record and the blank tablets are simultaneously revolved, the variations in the groove of the "master" record impart, through the rubbing style and the connecting lever, motion to the cutting or graving style imbedded in the blank tablet, thereby causing it to cut a record in the blank exactly corresponding to the "master" or "original" record. This form of apparatus is based upon the U. S. Patent to Sumner Tainter No. 341,287, as improved in the manner shown in Bettini's U. S. Patent No. 488,381, and perfected by Thomas H. Macdonald and described in his U. S. Patent No. 559,806.

From the foregoing, it will be manifest that a "duplicate" record thus produced is *not the product of a graphophone,* but is a distinct article, the product of an apparatus whose *modus operandi* is quite different from that of the graphophone.

The "original" is the product of the graphophone, the "duplicate" is a mechanical copy of the "original," but is produced by a different apparatus.

It is also evident from the description of duplicating machines given above that they are highly specialized machines, designed and constructed for the sole purpose of making engraved duplicates of original records, and that they are not susceptible or capable of being used for any other purpose.

I am familiar with the testimony given by the defendant Walcutt herein, and believe that I understand the type of apparatus used by the defendants in the manufacture of infringing sound records. That apparatus consists, briefly, of two revoluble mandrels, one carrying a blank and the other a master record. Located between these are, first, a rubbing style coacting with the groove in the record tablet, and, second, an engraving style coacting with the blank, and, third, a mechanical appliance connecting the graving style with the rubbing style. The undulations in the groove of the record impart motion to the rubbing style, which in turn imparts a movement to the engraving style, thereby duplicating in the blank the groove formed by the record.

I have examined the sound record marked "Complainant's Exhibit Defendant's Duplicate Sound-Record," and referred to in the affidavits of E. N. Burns and V. H. Emerson herein, which I have read. This exhibit is the ordinary commercial sound-record defined in claims 7, 8, 10 and 17 of the Bell and Tainter Patent in suit, being in every structural and physical characteristic identical with the Complainant's Exhibit Defendant's Sound-record, with reference to which I testified in my deposition already referred to.

Duplicating machines, such as I have herein described, and such as Walcutt described as the means whereby he manufactured duplicates, cannot be used for any purpose except to produce duplicate sound-records having the characteristics of this exhibit.

SHELTON T. CAMERON.

Sworn to and subscribed before me
this 5th day of February, 1898.

EUGENT CONRAN,
(SEAL.) Notary Public, Kings Co.

Certificate filed in New York Co.
(A true copy.) C. A. L. M.

UNITED STATES OF AMERICA, } ss.
SOUTHERN DISTRICT OF NEW YORK, }

I, JOHN A. SHIELDS, Clerk of the Circuit Court of the United States in and for the Second Circuit and Southern District of New York,

DO HEREBY CERTIFY that I have compared the preceding with the original affidavits of Edward D. Easton, C. A. L. Massie, Philip Mauro and Shelton T. Cameron in the cause entitled American Graphophone Company vs. Walcutt & Leeds, Ltd., et al., said affidavits being attached to the order to show cause in the above entitled cause, filed March 3, 1898, on file and of record in my office, and that the same are true and correct transcripts therefrom, and of the whole of said originals.

(SEAL.) IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the Seal of said Court, at the City of New York, in the District and Circuit above named, this 12th day of March, in the year of our Lord one thousand nine hundred and nine, and of the Independence of the United States the one hundred and thirty-third.

(Signed) JOHN A. SHIELDS,
Clerk.

UNITED STATES CIRCUIT COURT,
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY.
} In Equity on Letters Patent No. 683,615.

NATIONAL PHONOGRAPH COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY.
} In Equity on Letters Patent No. 683,676.

NEW JERSEY PATENT COMPANY,
vs.
AMERICAN GRAPHOPHONE COMPANY.
} In Equity on Letters Patent No. 831,668.

"Complainants' Exhibit—Cameron Deposition in Connecticut Suit on Edison Patent No. 713,209."

DISTRICT OF CONNECTICUT,
UNITED STATES OF AMERICA, } SS.

I, R. F. CARROLL, Deputy Clerk of the Circuit Court of the United States for the District of Connecticut, do hereby certify that the annexed paper is a true copy of the original deposition of Shelton T. Cameron, in

NATIONAL PHONOGRAPH CO.
vs.
AMERICAN GRAPHOPHONE CO.
} No. 1103 Equity

recorded and on file in said Court.

IN TESTIMONY WHEREOF, I have set hereto

my name officially and the Seal of said Court, at Hartford, in said District, this 6th day of May, A. D. 1909.

R. F. CARROLL, Deputy Clerk.

IN THE CIRCUIT COURT OF THE UNITED STATES.
DISTRICT OF CONNECTICUT.

NATIONAL PHONOGRAPH CO. *Complainant,* *vs.* AMERICAN GRAPHOPHONE CO. *Defendant.*	In Equity. No. 1103.

Testimony taken for final hearing on behalf of the defendant before Reeve Lewis, Esq., a Notary Public, at the offices of Philip Mauro, No. 620 F St., N. W., Washington, D. C., on this 16th day of March, 1904, by agreement of counsel.

Present: R. N. DYER, Esq., for complainant; PHILIP MAURO, Esq., for defendant.

And thereupon, SHELTON T. CAMERON, being duly sworn, deposes and says a sfollows:

DIRECT EXAMINATION.

Counsel for defendant offers in evidence printed Patent Office copies of the specifications and drawings of the following U. S. Patents: Bell & Tainter, No. 341,214; Tainter, No. 341,287; Edison No. 382,417; Edison No. 393,462; Edison No. 400,647; Edison No. 406,576; Edison No. 484,582; Edison No. 488,191; Edison No. 667,662; Macdonald No. 559,806; Macdonald No. 606,725; Lioret No. 528,273; Appelt No. 303,970; Day No. 563,572.

Also a copy of British Patent to Young No. 1478 of 1894.

The foregoing patents are marked in evidence by

Raymond R. Wile Research Library

the titles given above preceded by the words "Defendant's Exhibit."

Defendant also offers in evidence a certified copy of the file and contents of the patent in suit which is marked "Defendant's Exhibit, File and Contents of Patent in Suit."

Also the following exhibits which have been filed in suit No. 1076 between the same parties, to be known by the same titles as given them in that suit:

"Defendant's Exhibit, Macdonald's 1895 Mold."

"Defendant's Exhibit, Photograph of 1895 Mold."

"Defendant's Exhibit, Photograph of 1897 Mold No. 1."

"Defendant's Exhibit, Photograph of 1897 Mold No. 2."

"Defendant's Exhibit, Blank Mold."

Q. 1. What is your name, age, residence and occupation?

A. Shelton T. Cameron; age 46 years; Washington, D. C.; lawyer, making a specialty of patent causes, and mechanical expert.

Q. 2. Please state briefly what education and experience you have had which would qualify you to testify as an expert in patent causes, and particularly what experience, if any, you have had in the art of recording and reproducing sounds?

A. I was for many years an examiner in the U. S. Patent Office, where it was a part of my daily duty to examine applications for patents and report upon the patentability or non-patentability thereof. Since severing my connection with the Patent Office I have been continuously engaged in the practice of my profession, have prosecuted numerous applications for patents, made examinations and given opinions upon questions of patentability, infringement and identity of alleged infringing articles with patentable structures. I have also repeatedly visited workshops and manufactories for the purpose of inspecting and study-ing mechanical structures, and particularly have I familiarized myself with the patented and practical art of recording and reproducing sounds. I have made exhaustive studies of sound records, have familiarized myself with the actual commercial manufacture of talking machines and sound records, and have given a great many depositions and expert affidavits in causes pending before the U. S. Courts, wherein patents relating to the art of recording and reproducing sounds were in question. On the subject of the production of sound-records by forming them in a mold, I have lately given a deposition in a suit between the parties to the present suit, the earlier suit being upon Edison's Patent No. 667,662, dated February 5, 1901.

Q. 3. Have you read and do you understand the patent in suit, No. 713,209; if so, please state briefly what supposed invention or improvement is set forth in claims 2 and 3 thereof, comparing said claims with those of the earlier Edison Patent No. 667,662, referred to in your last preceding answer.

A. I have carefully read the specifications of Patent No. 713,209, in suit, and I understand it.

The patent relates to the production of sound-records (particularly cylindrical sound-records) by the use of a mold. In the making of the mold an original sound-record, cut or engraved in wax-like material, is used as the pattern from which the mold is made.

The specification states that the mold may be made "by any of the known processes—as for example, those indicated in my patent No. 484,582," which patent has been put in evidence by complainants and is referred to in the deposition of complainant's expert witness, Mr. F. L. Dyer. The making of the continuous cylindrical mold being old, the patent in suit relates only to the manner of using the old mold.

In the earlier patent, No. 484,582, it was proposed to make the sound-records by "casting," that is, by melting the wax-like material and pouring it into the mold around a suitable core.

The leading thought in the patent in suit, distinguishing it as a departure from the 1892 patent No. 484,582 (as well as from the 1901 patent No. 667,662) is that the record is formed by introducing into the mold wax-like material in the form of a *solid* blank cylinder of a diameter (under normal temperature) to fit closely within the mold and by then expanding the blank cylinder so as to cause it to come into contact with (and to receive an impression from) the inner surface of the bore of the mold. This operation or procedure has been called for convenience a "pressing" operation, to distinguish it from a "casting" operation, such as described in the two prior Edison patents referred to above, and from a "dipping" operation as described in Patent No. 683,615 to Miller & Aylsworth, referred to in the deposition of complainant's witness, Miller (Complainant's Exhibit Miller & Aylsworth Method Patent No. 683,615).

The patent in suit appears to be based wholly upon the difference between *casting a molten material* into the mold, and introducing therein a *solid blank* which is *expanded* into close contact with the surface of the mold. This appears from the description of the invention in which the only departure from previous practice is in the formation of the record by the expansion of a solid blank within the mold. This is emphasized by the fact that the specification refers directly to Edison's prior patent of 1892, No. 484,582, wherein the formation of the record (when wax-like material was used) was by casting.

The description of the process of the patent in suit begins at the top of page 2 of the printed specification.

It deals solely with the manipulation of a solid "blank," and it is stated that this blank must have sufficient thickness to maintain its shape "during and after the act of disengagement from the matrix" (p. 2, ls. 12-14 and ls. 126-128). The word "blank" is used more than forty times in the specification, and the drawings indicate apparatus which could only be used with a *solid* blank. So far as the specification is concerned, the use of a liquid or molten material appears to be excluded from contemplation.

The expansion of the blank into intimate contact with the mold is effected by the application of heat either to the blank alone, or to both blank and mold (p. 2, ls. 18-27). To obtain the desired result the blank is preferably composed of a material having a higher coefficient of expansion than that of the mold, in which case it is said that the blank will come into contact with and receive an impression from the mold when both blank and mold are heated (ls. 33-40).

But the patentee prefers, "in order to facilitate the operation and make the resulting duplicate somewhat sharper," to assist in the expansion of the blank by the forcible introduction of a tapering plug or mandrel (p. 2, l. 41, *et seq.*).

It is also stated that, with certain classes of material, "the entire expansion may be effected mechanically by forcing a tapering mandrel within the same," *i. e.*, within the blank.

Whether the expansion be effected by heat, or by driving in a tapering plug, or by application of both these means, it is clear that they could be applied only to a *solid blank*. They could have no application to, and indeed are absolutely inconsistent with, the use of a molten material poured into the mold, which must receive the configuration of the internal surface of the mold by the congealing of the melted material in contact therewith.

Therefore, from the reading of the specification, and from the fact that the prior patent referred to therein describes a casting operation, I understand that, by the patent in suit the patentee intended to disclose, and did disclose a procedure wherein the prominent and essential step consisted in *expanding a solid blank tablet within the mold,* until it received an impression therefrom.

The claims to which the question is directed read as follows:

> "2. The method of producing hollow cylindrical phonograms, which consists in obtaining a mold having a reverse phonogram-record on the inner wall of a cylindrical opening, forming a hollow cylindrical plastic phonogram within said mold, releasing the phonogram from the mold by a radial contraction of the phonogram sufficient to entirely clear the surfaces, and removing the phonogram from the mold by direct longitudinal movement.
>
> "3. The method of producing hollow cylindrical phonograms which consist in obtaining a mold having a reverse phonogram-record on the inner wall of a cylindrical opening, forming a hollow cylindrical plastic phonogram, within said mold, releasing the phonogram from the mold by a reduction in temperature sufficient to entirely clear the surface, and removing the phonogram from the mold by direct longitudinal movement."

Claim 2 sets forth a "method of producing hollow cylindrical phonograms," which method consists in (1) obtaining a suitable mold, (2) forming a hollow cylindrical plastic phonogram within said mold, (3) releasing the phonogram from the mold by a radial contraction of the phonogram sufficiently to entirely clear the surfaces, and (4) removing the phonogram from the mold by a direct longitudinal movement.

In view of the prior art as exemplified by the patents here in evidence, it is evident that the "method" defined in this claim can be considered a departure from previous methods of molding cylinders of wax-like and other materials, if at all, solely in that part of the method which is defined by the words "forming a hollow cylindrical plastic phonogram within said mold." This conclusion is also reached by examination of the specification, which points out, as the salient feature of the invention, the expansion of the solid blank within the mold.

There is room for doubt and discussion as to just what meaning is to be given to the word "plastic" in these claims, inasmuch as that expression is not used in the specification. It is a relative and indefinite term, but taken in connection with the specification, it is to be given, in my opinion, a broad interpretation. A substance may be termed "plastic" if, in the particular operation in which it is used, it is capable of being impressed by a die or mold; although it might not ordinarily be termed "plastic," as that term is usually employed in the arts. The wax-like material used in the talking-machine art would not ordinarily be termed "plastic," but when forcibly expanded against the surface of a mold would undoubtedly receive the impressions of such surfaces, and hence would be plastic for that purpose. I, therefore, understand the second step of the claim to mean bringing a solid *impressible* material (*i. e.,* a material capable of being *molded* by the means in contemplation), into contact with the mold surface, as distinguished from bringing a liquid material into contact therewith and permitting the liquid to congeal. It is, to my mind, clear that this is the line which the patent draws between what is included in and what is excluded from it.

That I am correct in my understanding that the *invention* disclosed in the patent in suit is one limited to the expansion of a solid blank within the mold, is clearly shown by the act of the inventor during the prosecution of the case in the Patent Office. By an amendment dated September 1st, 1898, and filed September 2nd, 1898, he erased several claims, among which was original claim 1, which was as follows:

> "1. The process of duplicating cylindrical phonograms having a record thereon, which consists in forming a matrix or mold wherein the original record will be reproduced in relief, in loosely engaging the continuous cylindrical blank phonogram with the said matrix or mold, and in finally intimately engaging the blank phonogram with the said matrix or mold whereby the entire record will be impressed upon said blank phonogram simultaneously, substantially as set forth."

This claim is a fair sample of the other claims erased by the same amendment, and in explanation of the reasons why said claims were erased, applicant said:

> "The claims which have been erased are canceled in view of the fact that they appear to cover processes which are broader than applicant's *invention,* namely, processes wherein the blank in the process of duplication is *displaced* instead of being *expanded."* (Italics mine.)

It thus appears that during the prosecution of the case in the Patent Office, the applicant considered that claim 1, which I have herein quoted, was broader than the *invention* disclosed in the specification, because it was broad enough to include the use of a solid blank which might be "displaced" to cause it to take the impression in the mold, whereas applicant's invention was *limited strictly to a process where a blank was "expanded."* The distinction which applicant made between "displacement" and "expansion" he pointed out to be that, in the case of "expansion," the blank was first enlarged and then subsequently contracted—like the expansion of a rubber band—whereas, in the case of "displacement," the blank was enlarged and after leaving the mold it was larger than when it was originally inserted therein. It will be observed that this is a very fine distinction, and yet applicant regarded a claim which was broad enough to include both of these as being broader than his invention, and pointed out that his invention was limited to the expansion of a solid blank within the mold. Obviously, there is a greater difference between casting molten material into the mold, and expanding a solid blank within the mold, than there is between displacing a solid material within the mold which does not subsequently contract to its original size—and that of expanding a solid blank within the mold, which does subsequently contract to substantially its original size.

Claim 3 differs in no respect from claim 2, except in that it specifies that the contraction of the record is effected by a "reduction of temperature." This distinction is one of scope merely and in reality has no substance, since shrinking out the molten article by cooling it is the common practice in the molding art, and is the only means indicated in the patent in suit.

On comparing the procedure of these claims with that of Edison's prior patent No. 667,662, I find that the difference lies solely in the fact that the said prior patent describes the formation of the record by introducing *melted material* into the mold and allowing it to congeal. Thus, comparing claim 2 of the patent in suit with claim 4 of the prior Edison Patent No. 667,662, we find that they are identical excepting that where the earlier patent specifies "introducing a *molten* material in the mold to form a cylindrical duplicate and allowing the duplicate to set" (*i. e.*, congeal) the patent in suit specifies "forming a hollow cylindrical plastic phonogram within said mold."

This will be clearly seen by placing the steps of the compared claims in parallel columns.

PATENT IN SUIT, CLAIM 2.	PRIOR PATENT NO. 667,662, CLAIM 4.
(1) Obtaining a mold, etc.	(1) Forming a cylindrical mold, etc.
(2) Forming a hollow cylindrical plastic phonogram within said mold;	(2) Introducing a molten material in the mold to form a cylindrical duplicate, in allowing the duplicate to set.
(3) Releasing the phonogram from the mold by a radial contraction;	(3) Contracting the duplicate;
(4) Removing the phonogram from the mold by direct longitudinal movement;	(4) Removing the contracted duplicate by a direct longitudinal movement.

If the term "plastic phonogram" used in the claim of the patent in suit were taken to apply to and include the process of the earlier patent, there would be *no* distinction between the two patents (so far as affects the claims involved in this case) except one of scope.

Complainant's expert, Mr. Dyer, construes claims 2 and 3 of the patent in suit as broad enough to include an operation wherein the record is formed by casting a melted material. He, therefore, finds that claims 2 and 3 of the patent in suit differ from those of the earlier patent, No. 667,662, merely in that the claims of the patent in suit are broader in scope than those of the earlier patent. That is to say he gives it as his opinion that the words "forming a * * * plastic phonogram," embrace forming a phonogram by casting a molten wax into the mold, as in the two prior Edison patents to which I have referred.

The word "plastic" does not appear anywhere in the body of the specification, and we do not have, therefore, in the patent itself any clear definition as to what meaning is to be attached to this word in claims 2 and 3. I have been unable, after careful reading of Mr. Dyer's deposition, to ascertain just what limitations he places upon the term "plastic," as used in these claims, but from study of his answers found on pages 67-68 in complainant's record, it is clear that he regards the term "plastic" as broad enough to include any material capable of receiving and retaining the configuration or outline of the record in relief on the interior of the mold; and it is equally clear that he regards the expression "forming * * * a plastic phonogram," as used in these claims, as being intended to include the act of melting and pouring into the mold any material which when it congeals will have been found to have received the configuration of the relief record existing on the interior surface of the mold. I cannot agree with this interpretation of the expression "forming * * * a plastic phonogram," since to thus construe the expression would be to give to claims 2 and 3 a meaning broader than the invention set forth in the body of the specification, when the same is viewed in the light of the prior art. As I have previously indicated, the invention set forth in the body of the specification, and the one to which all of the claims, except claims 2 and 3, are specifically limited, consists in inserting a body of solid material into the mold and expanding said body of solid material against the interior surface of the mold whereby the record on the interior of the mold is impressed into the surface of the solid body.

If the act of melting and pouring the material into the mold and allowing it to congeal, whereby it receives the configuration of the interior surface of the mold, is regarded as the equivalent in this art of expanding a solid body so as to cause it to receive the impression of the interior surface of the mold, then the invention defined in claims 2 and 3 of the patent in suit would be *the same invention* as that set out in Edison's prior patent No. 667,662, and claims 2 and 3 of the patent in suit would differ from claims 4 and 5 of the said prior patent only in scope. The invention defined in the two patents would be the same, though the breadth or scope of the claims mentioned would differ. For this reason, among others, I am clear that the expression "forming * * * a plastic phonogram within said mold," as this expression is used in claims 2 and 3 of the patent in suit, cannot be construed to include the act of pouring molten material into the mold and allowing said material to congeal.

In my opinion, the step or operation described by the words "forming a hollow cylindrical plastic phonogram" is broad enough to include any operation wherein a hollow blank in a solid state is expanded outwardly against the mold surface and receives the impress thereof, but not broad enough to include the operation of introducing a melted material into the mold and allowing it to congeal so as to receive the configuration of the relief record on the interior of the mold.

As a further indication that the formation of a sound-record by casting is not contemplated by these claims (2 and 3), any more than by the other claims and by the body of the specification, from all of which it is positively excluded, I call attention to the fact that in *casting* a sound-record, there is no point or stage in the procedure at which it can be said that a "plastic" sound-record is formed. In cooling down from the melted to the solid state the material of course passes through all intermediate degrees of plasticity; but it would require a great straining of what actually occurs to say that one step of the operation consists in forming a plastic phonogram.

For these reasons I conclude:

1. That claims 2 and 3 do not include the operation of casting a sound-record as set forth in claim 4 (and other claims) of Edison's prior patent No. 667,662.

2. That, if construed as including an operation wherein the record is formed by casting a molten material into the mold, the claims (2 and 3) of this patent in suit would be identical in substance with, and differ only in scope from, the claims (especially claim 4) of the said prior Edison patent. According to this interpretation, the claims (2 and 3) of the patent in suit, differ from claim 4 of the earlier patent simply in being broader or more generic in scope.

Q. 4. Please compare the procedure of claims 2 and 3 of the patent in suit with the prior Edison patent No. 484,582, of October 18, 1892, referred to therein.

A. The patent in suit says that the 1892 patent No. 484,582 describes a process of making a mold suitable for use in carrying out the method of the patent in suit (p. 1, paragraph beginning line 43). Since the patent in suit contemplates the use of a *continuous* cylindrical mold, I should understand from this reference that said 1892 patent describes a way of making a *continuous* cylindrical mold. Upon examination of said 1892 patent this understanding is found to be correct.

Therefore, up to the point of the *making* of the mold, the two patents are identical.

In the *use* of the mold, there is a difference in that the 1892 patent refers to pouring wax-like material into the mold, and also to pressing sheets of paper or tinfoil against the surface of the mold by means of a plunger or otherwise, and backing up these sheets by wax, cement or the like. The patent in suit describes the different operation of expanding a solid *tubular* blank within the mold.

This blank must be thick enough to maintain its shape during and after engagement from the mold (p. 2, lines 11-14). This limitation was evidently introduced to distinguish from the use of thin pliable sheets of material such as paper or tinfoil. Thus the patent in suit specifically demands not only a tubular blank in a *solid* state, but one having a certain thickness and rigidity. This is what distinguishes the method of the patent in suit from that of the 1892 patent.

In the 1892 patent, the patentee proposed going somewhat further than in the patent in suit. He evidently thought he could facilitate removal of the record from the mold, and possibly save the time which is required for a melted material to cool and contract sufficiently for removal from a cylindrical mold, by resorting to the common expedient of dividing the mold longitudinally into sections. Such a mold can be opened to deliver the cast article, and the mold immediately re-used. This suggestion, however, was not well considered, and it would seem that, in making it, Mr. Edison did not take into account the effect of the lines of division between the sections of the mold in forming minute fins upon the surface of the molded record. These minute fins would produce sharp noises, as of percussions, and impair the success of reproduction of the recorded sounds. Complainant's expert points this out, saying (p. 21):

> "it is *obvious* that, however carefully the joints between the sections might be made, it would be impossible to prevent the formation of a minute fin or burr on the duplicates at each joint, which would destroy their commercial character." (Italics mine.)

I concur in this statement, and hence it is "obvious" that the methods of the 1892 patent, the claims of which include the use of a continuous mold as well as of a split mold, could only be carried out to a satisfactory result by means of a continuous mold, which, of course, involves permitting the cast record to remain in the mold until it has cooled and contracted sufficiently to admit of withdrawal longitudinally.

Adjourned to Thursday, March 17, 1904, at 10:30 A. M.

March 17, 1904, 10:30 A. M.

Met pursuant to adjournment.

Parties as before.

(Answer continued.) I therefore find, upon comparing claims 2 and 3 of the patent in suit with the prior patent No. 484,582, that the only difference between the procedure of said claims and what is disclosed in said prior patent is in the forming of the record by expansion of a solid blank of material sufficiently plastic (*i. e.,* impressible) to take the impress of the surface of the mold, instead of casting a molten material.

Q. 5. Assuming that claims 2 and 3 of the patent in suit are, as complainant's expert says, not limited to forming the sound-record by expanding a solid blank, but include casting a record therein, do you or not find any substantial difference between such claims and the prior 1892 patent?

A. Making the assumption stated in the question, there is no substantial difference between the procedure of claims 2 and 3 and that disclosed in the 1892 patent. The claims are for a "method," *i. e.,* for a definite mode of procedure whereby a mass of material (such as wax) in the form of a hollow cylinder receives upon its surface the impression from a mold of an undulatory line representing sound-waves. The 1892 patent specifies making a *"hollow"* cylindrical record because it describes pouring the material, "such as wax or wax-like material" into the mold and "preferably around a suitable core." If the method of the patent in suit is assumed to be the same in this respect (*i. e.*, in introducing a molten material into the mold) as that of the 1892 patent, we must seek a difference, if any, in a later stage of the process. While the 1892 patent describes removing the record by opening the mold (which is to be made in sections for that purpose) I do not consider that it required any additional disclosure to enable a person skilled in the art to use the mold in its original continuous condition. In other words, the 1892 patent describes the making of a *continuous* cylindrical mold. It does not describe the manner of using such mold, because the use of such molds was well understood in the art of casting plastic materials, and even in this talking-machine art (see defendant's exhibit, Appelt patent No. 303,970, and Edison Patent No. 382,417. The 1892 patent then goes a step farther, proposing that the mold be divided into sections so that it could be opened. We have, therefore, in this 1892 patent a cylindrical mold in each of its two known forms, *i. e.*, continuous and sectional, the use of each being well known. In my opinion it did not require a further invention or disclosure after the 1892 patent to retrace the step which carried Mr. Edison from the use of the continuous mold to the sectional mold. This was not a step forward, but a step backward—merely retracing a step which Mr. Edison found carried him away from the path of practical success.

My conclusion in this regard is absolutely confirmed by evidence in this case on behalf of complainant.

To put the matter another way, the question whether a substantial difference is here presented depends upon what was, prior to the patent in suit, within the knowledge and skill of persons familiar with the art of molding, and upon what would or would not be obvious to persons skilled in that art. I quite agree with complainant's expert, Mr. Dyer, in his statement that it is obvious that the split mold of the 1892 patent could not be successfully employed; and I think it is equally obvious to one skilled in the art that the material could be cast in the continuous mold disclosed by the 1892 patent, and then withdrawn longitudinally.

I give it as my opinion, and think there can be no doubt about it, that to give a skilled workman the continuous cylindrical mold described in patent No. 484,582, and shown in Fig. 4 thereof, and also the "wax-like material" mentioned in the patent, and to tell him to cast said material therein, would put him in possession of all the directions necessary. He would know, and indeed it is obvious to all persons having ordinary intelligence and information, that the melted material must be allowed to remain in the mold until released "from the mold by a reduction in temperature sufficient to entirely clear the surfaces" (as specified in claim 3 of the patent in suit), after which the record would be removed "by a direct longitudinal movement."

If I have not overstated what would lie within the knowledge of persons skilled in this art, it is clear that everything which claims 2 and 3 of the patent in suit set forth subsequent to the step of forming the phonogram, follows inevitably from the use of a continuous cylindrical mold, and can not possibly be regarded as embracing any novelty at the time of the grant of the Edison 1892 patent No. 484,582.

I further give it as my opinion that it would, in 1892, be obvious to persons skilled in the art, that the suggestion of splitting the mold would be disadvantageous; but if anyone were not bright enough to see this without experiment, he would immediately discover it and do as Mr. Edison did four years before he issued this patent, namely, discard this suggestion as disadvantageous and use the mold in its original continuous condition.

I find then that the 1892 patent disclosed a practical way of making a continuous sound-record mold (the use of which was well understood), and also contained a disadvantageous suggestion; but I am of opinion that the disadvantageous character of this suggestion was obvious at the date of said patent, or at least so readily ascertainable as not to mislead.

In this opinion I am absolutely confirmed by the evidence given herein on behalf of the complainant.

In the passage which I have quoted above from Mr. Dyer's deposition, he asserts that:

> "It is *obvious* that, however carefully the joints between the sections might be made, it would be *impossible* to prevent the formation of a minute fin or burr."

He says again (p. 21) that:

> "Success can *only* be obtained when the matrix or mold is *continuous* and where the duplicates are removed by shrinking them radially."

Again he says in answer to x-Q. 13 (p. 31), assuming the mold to be formed from a record having a shallow-cut groove, that:

> "It is *absolutely incredible to me that any one should use a sectional mold*, because as I point out in my direct examination, the joint between the mold sections *must inevitably* produce a minute fin on the duplicate corresponding to each joint."

He goes on to say that it would be *"just as foolish"* to use a sectional mold as it would be to deface a continuous mold by longitudinal scores or creases.

While I would not go so far as to say that Mr. Edison had, in suggesting in his 1892 patent that the mold might be split, made a suggestion so absurd and foolish as Mr. Dyer seems to think, it is unquestionably a fact that anyone following this suggestion would instantly find its result unsatisfactory (as Mr. Edison did) and would hence revert (as he did) to the continuous mold. Indeed, I find this to have been precisely Mr. Edison's experience. He says that in the year 1888 he employed the continuous mold and the method of shrinking the record out, and that thereafter he always used that method of getting the record out of the mold, no matter how the record was formed (I refer to Mr. Edison's answers to questions 15, 16 and 17 on page 208 of complainant's record).

It thus appears that for four years before the 1892 patent issued, and for four years before the application therefor was renewed (which was on March 30, 1892) the expedient of splitting the mold had been discarded entirely by Mr. Edison. It follows that the only satisfactory way in which the claims of the 1892 patent could be carried out was by the use of a continuous mold. I quote claim 4 of that patent:

> "4. The process of duplicating phonograms carrying a phonographic record, consisting, first, in indenting the original record upon a phonogram; second, constructing a matrix or mold of such original record by depositing thereon a coating of metal by vaporizing metal in a vacuum in which the record is placed, and, third, producing duplicate phonograms from such matrix, substantially as set forth."

Since it was, as Mr. Dyer says, "obvious" that the expedient of splitting the mold could not be used with satisfactory results, it of necessity follows that what this 1892 patent disclosed at the time of its issue to all persons sufficiently well informed in the art, or sufficiently intelligent to take notice of what is "obvious," was a method of making duplicate sound-records by means of a continuous cylindrical mold made by the vacuous-deposit method, the material being melted and poured into the mold, and allowed to cool therein until sufficiently contracted to admit of longitudinal withdrawal.

The 1892 patent, therefore, discloses fully the procedure of claims 2 and 3 of the patent in suit if we interpret those claims to mean casting a sound-record therein, and as not limited to expanding a solid blank.

If, instead of considering what was obvious, we consider what had been actually *proposed and done* in this art in casting sound-record cylinders in continuous cylindrical molds, using the very materials proposed in the 1892 patent (*i. e.,* "wax or wax-like material") and shrinking the cylinder by a reduction of temperature clear of the mold, we reach the same conclusion as to the extent of the disclosure of the 1892 patent.

Q. 6. Please compare the methods of claims 2 and 3 with the method of making blank cylinders or tablets for sound-records, referring in particular to Edison's Patent No. 382,417, May 8, 1888.

A. In making blank cylinders or "phonograms" it has long been customary to cast the wax-like material in continuous cylindrical molds, and after congealing and sufficient contraction of the cylinder, removing it from the mold by a direct longitudinal movement. Such method is identical with that of claims 2 and 3, unless we limit those claims to a method of expanding or pressing the cylinder against the surface of the mold.

In making this statement I do not ignore the fact that the claims specify the use of molds having a surface impression of a sound-record; but it is obvious that the nature of the surface of the mold is not a part of the method of using the mold.

In making blanks it is customary, after the casting operation, to improve the finish of the surface as by turning or shaving. Hence, in the ordinary manufacture of blanks no particular care is exercised in withdrawing the casting from the mold to prevent marring its surface. I refer to this, because Mr. Dyer seems to think that the process of casting a sound-record is different from that of casting a blank in that the latter is withdrawn from the mold forcibly and without exercise of any particular care, and is subsequently shaved or polished. To my mind, nothing that is done or omitted after the casting operation is completed, can change the fact that blanks are, and long have been, made by casting in a continuous cylindrical mold, allowing them to contract radially, and then withdrawing them lengthwise. Nor does a variation of the *degree* of cooling and shrinkage allowed to take place in the mold change the nature of the process.

The Edison patent, referred to in your question, No. 382,417, May 8, 1888, shows that the forcible or violent removal of the blank from its mold is not always contemplated, and that it would not be a novelty or an inventive act to allow the blank to remain and contract in the mold.

The patent describes specifically the making of a blank cylinder in a cylindrical mold, and finishing it in another mold. For the first part of the operation (casting the blank) it is proposed to use a two-part mold; but it is said that the mold may be of "any other suitable construction." The description of the procedure is as follows:

> "E is the tapering core of the mold. The mold is swung to the left over the solid part of the base, and the core being placed in it and the mold closed, hot wax is poured into the mold, forming a cylinder around the core E.

> When the wax is partially cool, sufficiently so to retain its shape, the mold is swung to the right over the opening D and the core E is pushed down into the opening D, as shown in Fig. 2, thus permitting the wax to contract without breaking. After the cylindrical blank has cooled down to a temperature where it is still slightly plastic—say 100 degrees Fahrenheit—it is removed from the mold and is placed in the die F. This die may be a divided die or one that is solid. It has a cylindrical opening with a shoulder *a*, at its lower end. A tapering plunger, G, pressed forward by a screw, H, is forced into the bore of the phonogram blank, pressing the blank against the walls of the surrounding die, and giving it the exact shape and size both externally and internally that it is desired the blank should have. The die and its plunger are made of highly polished metal. Speculum metal is preferably used for this purpose. The plunger is then removed from the blank and the blank removed from the die, when it will be ready for use on a phonograph."

Since continuous molds for use in casting blanks were known, it would not require invention to substitute a continuous mold for a divided mold in the first part of the process; and even without such substitution, the process is the same as when a continuous mold is used, for the wax cools down from the melting temperature (say about 250 degrees F.) to 100 degrees F. *while in the mold.* The shrinkage accompanying such reduction of temperature is far greater than what is required to clear a molded record from its mold. Therefore, I find in the first operation of Patent No. 382,417, a complete disclosure of the process set forth in claims 2 and 3 of the patent in suit, when those claims are construed as broad enough to cover the operation of casting a sound-record.

In considering the second part of the operation described in this Edison Patent No. 382,417, namely, that carried on by the die F (which is really another mold), it is not necessary to *assume* the use of a solid or continuous mold or die, as the patent expressly says that "this die may be a divided die or one that is solid." This statement demonstrates the recognized equivalency, even at that early day in the art, of continuous and divided molds.

Having then a continuous mold (or die), we are told by the patent to insert in it a wax cylinder at *"a temperature* where it is still *slightly plastic*—say 100 degrees Fahrenheit" (ls. 62-63), and to expand it against the surface of the mold by forcing into it a tapering plunger, so that it will take the exact shape of the mold. It is obvious that the removal of the wax-like cylinder, thus molded, is and can only be effected by allowing it to cool and contract, and then withdrawing it longitudinally.

The operation thus described to be carried out by means of the mold or die, is a true molding operation of the specific sort known as "pressing," and is, in my opinion, in every respect substantially the same as that set forth in claims 2 and 3 of the patent in suit. This statement holds good notwithstanding that, in the 1888 patent, the surface of the mold or die is a smooth, highly polished surface, whereas in the patent in suit a part of the surface of the mold or die is covered with exceedingly fine lines. The question relates simply to *method,* and it is quite clear that we have, in the two cases considered, identically the same method; that is to say, in each case a tube of wax-like material is introduced into a continuous cylindrical mold, is expanded forcibly against the inner surface of the mold, and is contracted and withdrawn lengthwise. In each case the *result* is the same, namely, the surface of the wax-like cylinder is caused to take perfectly the impression of the surface of the mold.

Identity of method and result is thus beyond question; and I think it accurate to say that the *instrumentalities* employed in the two cases are also identical in substance. These instrumentalities are a continuous mold and a tapering plunger. The mold does not become a different apparatus when part (or all) of its surface is covered by a pattern. Even a sound-record mold has a portion of its surface smooth and highly polished. Considered as an apparatus, it is clear that the part which is smooth and polished acts exactly as the part which has the shallow sound-record grooves, the action being to form the impress of the surface upon the substance treated.

I, therefore, conclude that the Edison 1888 patent No. 382,417 discloses the method set forth in claims 2 and 3 of the patent in suit.

Q. 7. Please compare claims 2 and 3 of the patent in suit with the U. S. patent to Lioret No. 528,273 and British patent to Young No. 1478 of 1894.

A. I will first refer to the Lioret patent. The only part which is pertinent is that which relates to molding cylindrical records. That this part of the patent is very pertinent to claims 2 and 3 of the patent in suit will appear by reading claim 3 of the Lioret patent, which is as follows:

> "3. The method of reproducing phonographic cylinders which consists in first obtaining a metal mold by electro-deposit upon an original phonographic cylinder, next placing bodily within the so obtained mold a solid ring of plastic material capable of being softened by heat, next softening this ring by heat, and finally so distending the said ring within said mold by internal pressure that it will receive therefrom an impression corresponding with that of the original cylinder, substantially as herein described."

To my mind, this language is a full disclosure of the broad claims 2 and 3 of the patent in suit, it being assumed (as must be the case) that the record is shrunk loose from the mold. It is not, however, necessary to make this assumption, since the specification (p. 2, l. 106) describes contracting the record and freeing it from the mold by plunging it into cold water.

There are specific differences between Lioret's procedure as a whole and that of Edison as a whole, but such differences do not affect the comparison which you have asked me to make, because they are not included in claims 2 and 3 of the patent in suit, particularly if we give them the broad construction contended for by Mr. Dyer. We have, in claim 3 of the Lioret patent, a clear statement of a process consisting broadly of the following steps: (1) forming a continuous metal mold by electro-deposit upon an original phonographic cylinder; (2) placing within the mold a solid ring of plastic material; (3) heating and expanding the ring until it receives the impression of the mold; (4) cooling and contracting the record.

We see that Lioret not only specifies expanding a ring of *plastic* material, but one of the very materials (celluloid) which Edison mentions as suitable for practicing his method.

It is clear that, whatever differences there may be between Edison's method and that of Lioret, they are not such as affect claims 2 and 3 of the patent in suit, the subject matter of which is fully disclosed in the Lioret patent.

The specific differences are these: Lioret makes his original sound-record on the apex of a V-shaped ridge, and consequently the surface of the mold will present a corresponding departure from the usual configuration of a sound-record mold. In consequence of this departure from the usual form of a sound-record, it becomes necessary, when the molded record is shrunk loose from the mold, to turn the latter with a screwing movement in withdrawing it. The movement given to the record in withdrawing it from the mold is not, in my opinion, a part of the process of making the record; and in any event involves merely the exercise of the most ordinary judgment.

I quote the description given in the Lioret patent of the method of molding:

> "To produce the cylinders of celluloid, I operate as follows: I prepare the matrix cylinder *a* (Fig. 4) as I have hereinbefore described. Then I take upon it, as is shown in Fig. 5, a galvano-plastic mold *a*1, which presents consequently the form of a tube having in its internal surface the counterpart of the threading and the impressions of the matrix cylinder *a*. (See Fig. 6.) I remove this tube from the matrix cylinder by first heating it externally to expand it sufficiently to enable it to be unscrewed from the said cylinder, the impression being so slight that very little expansion is necessary. After its removal I introduce into the said tube a sleeve or ring *c* of celluloid (see Fig. 7) just large enough to enter it freely, then plunge the whole into hot water. The celluloid is thus softened, and I then introduce forcibly into the said collar or ring *c* a mandrel *a*2 sufficiently large to dilate the said ring or collar and cause it to penetrate into all the cavities of the mold *a*, as shown in Fig. 8. I then plunge the whole into cold water and the celluloid recovers its hardness and is at the same time generally contracted sufficiently to permit the easy withdrawal of the ring *c* from the mold *a* by unscrewing it therefrom. If, however, the contraction of the ring *c* in this way is not sufficiently greater than that of the mold *a*, the mold may be slightly warmed by heat externally applied.
>
> "It may be here mentioned that the impression produced by the style on the matrix cylinder an dreproduced in reverse in the mold *a* is so slight that only a very slight dilation of the ring *c* is necessary to obtain the impression on it and a very slight contraction to permit it

> to be unscrewed from the mold *a* without damaging said impression.
>
> "It may be further mentioned that the threads of the matrix are very fine in practice and are very much exaggerated in the drawings to facilitate the illustration. This ring *c* thus becomes finally a reproduction cylinder which is an exact reconstitution of the matrix cylinder *a*. This method is rapid and economical and gives perfect results."

Inasmuch as the specific points of difference between the procedure of Lioret and that of the Edison patent in suit is brought about by a departure which Lioret proposes from the use of the ordinary smooth-surfaced record cylinder, that difference does not confer novelty upon the Edison procedure, which, in this respect, simply adheres to the ordinary practice.

Adjourned to Friday, March 18, 1904, at 10:30 A. M.

March 18, 1904.

Met pursuant to adjournment.

Parties as before.

(Mr. Cameron continues his answer to Q. 7.)

The Young British patent No. 1478 of 1894, mentioned in your question, distinguishes from the method described by Lioret (who had earlier English and French patents) in certain minor details. Beginning at line 31, page 1, of the Provisional Specification, Young describes making a cylindrical mold by coating a wax master record with plumbago, electroplating a metallic shell thereon and backing up this shell with a metallic body. This is the method whereby defendant makes its mold. Continuing (lines 12-22, page 2) Young describes molding a duplicate by warming the mold made as above stated, and introducing into it a thin hollow cylinder of "any suitable material *capable of being rendered plastic* by application of a gentle heat," and "pressing" the same against the surface of the mold, taking "an exact impression therefrom," after which the plastic cylinder is allowed to cool and is then withdrawn from the matrix or mold by a direct longitudinal movement. The description of Young's method given in his Complete Specification is substantially the same as that found in the Provisional Specification.

It will be observed that Young obtains his mold or matrix by coating the original record with plumbago and then electroplating the same, as it is stated in the patent in suit (page 1, ls. 69-72), may be done. Moreover, his manner of removing the original record from the electroplate is identical with one of the ways suggested in the patent (p. 1, ls. 91. 92), viz., by melting it out; furthermore, the thin electroplate thus obtained is backed up by an enclosing cylindrical jacket to give it the proper rigidity or "stability." Up to this point the method described by the Young British patent is in exact accord with the method described in the patent in suit, though the preferred method indicated by the patent in suit of obtaining the conducting coating for effecting the electro-deposit on the record is by the "vacuous" method described in Edison's earlier patent No. 484,532. This British patent, therefore, discloses the precise method of obtaining the mold of the patent in suit. unless we regard said method as limited to the vacuous deposit method of Edison's earlier patent.

Having thus obtained his matrix, Young introduces thereinto a thin hollow cylinder or blank of such diameter as to just fit within the mold, the matrix or mold having been previously heated or warmed. In defining the material of which this blank cylinder is composed, Young specifies that it "may be of any suitable material capable of being rendered plastic by the application of a gentle heat," and he specifically mentions celluloid and vulcanite as examples of such materials. Any expert in the art, however, would recognize the ordinary phonogram blanks made of wax-like material, such as metallic soaps or mixtures of saponified stearic acid and ceresin, as coming within the description which Young gives of a suitable material. That is, it was recognized at that time by everyone skilled in the art, that such tablets were "capable of being rendered plastic by the application of a gentle heat." It is therefore apparent that, while Young specifically mentions celluloid and vulcanite, it was clearly within the skill of the mechanic to substitute a blank made of wax or wax-like material for Young's blank of celluloid or vulcanite, because such blanks were, for the purposes of Young's invention, recognized equivalents in the art. That I am not mistaken in regarding the wax-like metallic soap blanks as the equivalents of the celluloid and vulcanite blanks of Young is clearly demonstrated by the fact that the patent in suit mentions polished ebonite, vulcanized hard rubber and celluloid as equivalent substitutes for a blank composed of stearic acid, which is the principal ingredient of the wax-like cylinders mentioned, and, furthermore, mentions these materials (ebonite, hard rubber and celluloid) together with "waxes." It therefore appears that, for the purposes of the patent in suit, it is a matter of indifference whether celluloid, vulcanite—which is but another name for ebonite or vulcanized hard rubber—or the wax-like blank, be employed.

Up to this point, then, the steps of the patent in suit are identical with those of the Young patent. The blank having been introduced within the mold, Young then proceeds to render the same capable of receiving the impressions of the mold by the application of heat, which, he says, "may be that given off from the heated electro and its casing." The blank having been sufficiently softened by the application of heat, Young then proceeds to "press the same gently and evenly up to and against the face of the electro and take an exact impression therefrom." The Young patent does not state any particular way, nor does it describe any particular apparatus to be employed in thus pressing the hollow cylindrical blank against the interior surface of the mold. This, however, was entirely unnecessary, in view of the fact that it was well known in the art—see Lioret patent above and Edison's U. S. Patent No. 382,417, of May 8, 1888—that a hollow cylindrical plastic phonogram, when warmed, could be pressed outward against the surface of a continuous mold by introducing a mandrel into the hollow blank. It will also be apparent that the heating of the hollow blank introduced by Young would also cause it to expand into contact with the mold, and that the use of the mandrel would only be necessary to obtain a sharper impression. We have, therefore, disclosed in the Young British patent the precise method of taking the impression that is described in the patent in suit, viz., heating the hollow blank while within the mold and then pressing it outward, *i. e.,* expanding it against the interior surface of the mold.

There would thus be formed "a hollow cylindrical plastic phonogram within said mold." This having been accomplished, Young then proceeds to reduce the temperature of the plastic phonogram thus formed, *i. e.,* he cools it. This would result in "releasing the phonogram from the mold by a radial contraction of the phonogram sufficient to entirely clear the surfaces," provided the cooling were carried to a sufficient degree. Young states, however, that he employs a very thin blank, and after cooling it he slightly collapses it and then readily withdraws it from the mold. Inasmuch, however, as the specific substance mentioned by Young, viz., celluloid, is one of the identical substances mentioned in the patent in suit as suitable for carrying out the process, and, moreover, is the only substance specifically claimed in the patent in suit (see claim 18), it must be apparent to anyone skilled in the art that if cooling a celluloid phonogram when practiced by Mr. Edison would result in sufficient contraction of the phonogram to cause it to entirely clear the surfaces of the mold, then cooling a phonogram made of the same material (celluloid) in the same kind of a mold would result in the same contraction when practiced by Mr. Young. Certainly, if one skilled in the art undertook to practice the method disclosed in the Young patent, and after obtaining the impression of the mold upon the warm plastic cylinder, should then proceed to cool it—as Young directs—he would inevitably find that his duplicate phonogram would be contracted sufficiently to clear the surfaces of the mold and permit him to withdraw it by a direct longitudinal movement. I do not regard Young's suggestion that he can remove a very thin cylinder from the mold by cooling and then slightly collapsing it as constituting a substantial difference between his method and that defined in the Edison patent in suit, since anyone skilled in this art would at once perceive that when he cooled the phonogram its contraction would be sufficient to permit its ready removal from the mold without the slight collapsing action mentioned in the Young patent.

Claims 2 and 3 of the patent in suit, in my opinion, are necessarily limited by the disclosure in the specification and the prior art to the method of forming the hollow, cylindrical plastic phonogram within the mold by expanding a solid body placed within the mold so as to obtain an impression of the relief record therein. But whether we regard these claims as thus limited or not, they are, in my opinion, anticipated by the method disclosed in the Young patent.

The claims in question define a method which consists in obtaining a mold having a reverse phonogram record on the inner wall of the cylindrical opening, and Young does this; the forming a cylindrical plastic phonogram within said mold, which Young also does; then releasing the phonogram from the mold by radial contraction due to cooling of the phonogram, and Young cools his phonogram. Up to this point the steps are the same, using the same apparatus and the same material, and the result must necessarily be the same, *i. e.,* a phonogram contracted sufficiently to entirely clear the surface of the mold and permit it to be removed therefrom by direct longitudinal movement.

During the prosecution of his application in the Patent Office, Edison presented the following claims:

> "1. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in forming a matrix or mold wherein the original record will be reproduced in relief, in loosely engaging the continuous cylindrical blank phonogram with said matrix or mold, and in finally intimately engaging the blank phonogram with the said matrix or mold whereby the entire record will be impressed upon said blank phonogram simultaneously, substantially as set forth.
>
> "5. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal upon the original phonogram so as to form a cylindrical matrix or mold, in inserting the continuous cylindrical blank to be reproduced within said matrix or mold, and finally in intimately engaging the blank with the record

> in relief carried by the bore of said matrix or mold, whereby the record will be simultaneously reproduced on said blank, substantially as set forth.
>
> "6. The process of duplicating cylindrical phonograms having a phonographic record thereon, which consists in depositing a metal upon the original phonogram so as to form a cylindrical matrix or mold, in inserting the continuous cylindrical blank to be reproduced within said matrix or mold, and in finally expanding the blank into intimate engagement with the record in relief carried by the bore of said matrix or mold, substantially as set forth.
>
> "12. The method of making hollow phonograms which consists in securing a hollow metallic shell with the reverse record therein, inserting an expansible blank in said shell and then heating both, expanding the blank by forcing a tapering plunger therein, withdrawing the phonogram, substantially as set forth."

These claims are found on pages 6 and 7 of the original specification and in the amendment of May 26, 1898, filed May 27, 1898, as will be found from an inspection of the certified copy of the file-wrapper and contents of the patent in suit, in evidence herein. These claims were rejected on the British Lioret patent and also on the British patent to Young No. 1478 of 1894, above mentioned. Subsequently, by an amendment filed September 1, 1898, Mr. Edison erased these claims, giving as a reason therefor that "they appear to cover processes which are broader than applicant's *invention,* namely, processes wherein the blank in the process of duplication is displaced instead of being expanded." It will be observed that each of these claims is limited to the employment of a blank inserted within the mold, which blank is subsequently caused to intimately engage the matrix or mold, claims 6 and 12 specifying that this is brought about by expanding the blank, and claim 12 even going so far as to specify that this expansion is brought about by introducing a tapering plunger within the blank and then further specifying that the phonogram thus formed is cooled and then withdrawn. Bearing in mind that Young and Edison employ the same material for their blanks (celluloid), it is perfectly clear that if Young secured a displacement of his material in practicing his process, then Edison must also have displaced the material of his blank, since he practiced the same process.

If we compare claim 12, quoted above, which was erased by Mr. Edison in the prosecution of this case, with claims 2 and 3 of the patent in suit, we find that said claim 12 certainly defines the making of a hollow metallic shell with a reverse record therein, the forming of a hollow cylindrical plastic phonogram within said shell or mold (this being done by inserting an expansible blank in said shell, heating and expanding the blank), reducing the temperature and then withdrawing the phonogram. And yet this, Mr. Edison says, is broader than his *invention*. We must, then, look for a definition of Mr. Edison's invention (if the same is included at all in claims 2 and 3 of the patent in suit), in that portion of step three of the claims which specifies that the reduction of temperature of contraction is "sufficient to entirely clear the surfaces" and in that limitation of step four which defines the removal of the phonogram as being secured by a "direct longitudinal movement." As I have heretofore pointed out, it had been known long prior to the date of the patent in suit that the contraction of the wax-like material theretofore commonly employed in the manufacture of blanks and records, was very great, being sufficient to not only entirely clear the surfaces of the mold, but to do this with a large margin to spare. For instance, Mr. Edison stated during the prosecution of the application that a contraction of .005 of an inch would be sufficient for this purpose, and it was well known, long prior to the date of the patent in suit, that the contraction of the material greatly exceeded this amount. Such being the case, it would be obvious to anyone versed in the art that if he cooled a cylinder of wax-like material which had been previously heated and expanded within Young's matrix, it would contract sufficiently to clear the surfaces of the mold, and thereby permit it to be removed from the mold by a direct longitudinal movement.

There is another view to take of claims 2 and 3 of the patent in suit in connection with the Lioret and Young patents which will also lead to the conclusion that there is nothing novel defined in said claims.

If one skilled in the art had before him the disclosure of the Lioret patent and undertook to make a duplicate record by said patent, he would employ a matrix or mold slightly different in character from that disclosed in the patent in suit and employed by the defendant herein, though as I have heretofore pointed out, I do not regard this difference in the mold as one having any practical bearing or effect upon the character of the *method* practiced, the steps of the operation of forming a duplicate not being in any way altered by the use of this slightly different mold. As is pointed out in the Lioret patent, the record employed to illustrate Lioret's invention is one having the undulations corresponding to sound waves impressed upon the apices of screw-threads previously cut upon a cylinder.

The record from which Young makes his matrix, however, is one of the ordinary records cut or engraved upon a wax cylinder, which record is electroplated precisely in the manner described in the patent in suit and employed by defendant herein. It appears, therefore, that at the date of the patent in suit both forms of record were well-known in the art, as were also electroplated matrices made from both records. If, then, a workman skilled in the art, should undertake to make a duplicate record according to the process disclosed in the Lioret patent, but instead of using Lioret's record formed on the apex of a screw-thread and the corresponding matrix or mold, he should substitute the matrix or mold of the Young British patent, he would be merely substituting one old and well-known form of apparatus for another equally old and well-known form. He would be merely doing what the skilled workman in the art is expected to do, viz., make a selection of such tools or forms of apparatus as he might deem best calculated to accomplish the particular end which he had in view.

Assuming that a skilled workman in practicing the method of the Lioret patent substitutes a Young matrix or mold for the one mentioned by Lioret, and then proceeds without any other departure whatever from the exact disclosure of the Lioret patent, he would practice the identical method set forth in the patent in suit; that is, he would obtain a mold having a reverse phonogram record on the inner wall of a cylindrical opening, which mold would be the identical mold used by defendant herein and described in the patent in suit; he would then insert within said mold a hollow blank composed of a material (celluloid) capable of being rendered plastic by the application of heat, and this material is the same material specifically mentioned and claimed in the patent in suit (see claim 18); he would then insert a tapering plunger within the plastic blank and expand it outward against the walls of the cylindrical mold, after which he would withdraw the plunger and cool the duplicate phonogram. At this point the phonogram would be sufficiently contracted to clear the surface of the mold so that it could be readily withdrawn by a direct longitudinal movement, and it would not be necessary to resort to the unscrewing movement which occurs when the form of record and matrix used by Lioret is employed.

In other words, if we substitute for the Lioret matric another old and well-known matrix (that of Young), as any skilled workman might do without making an invention, and proceed to follow step by step the process of the Lioret patent, we would necessarily practice step by step identically the same process described in the patent in suit; we should use the same form of matrix or mold; we should use the same material; we should render this material plastic and expand it in identically the same way (by heat and by plunger): and we should contract it in the same way (by cooling); and since the material and apparatus employed and the steps pursued are identical up to this point, we should get identically the same result, viz., a duplicate record so contracted radially as to clear the surface of the mold and permit its withdrawal from the mold by a direct longitudinal movement; that is, we should practice absolutely the method disclosed in claims 2 and 3 of the patent in suit, as well as many of the other claims.

For the reasons stated, I am clearly of the opinion that claims 2 and 3 of the patent in suit define nothing novel over the disclosures of the Lioret and Young patents mentioned in this answer.

Q. 8. What, in general, was the nature of the material used at the date of the Edison 1892 split-mold patent No. 484,582, and what was its capacity for shrinking under changes of temperature?

A. The material most commonly employed at and prior to the date of the Edison 1892 split-mold patent, referred to in your question, was of a wax-like character and generally composed of a mixture of waxes or materials, such as saponified stearic acid, which is of a very hard nature, tempered with waxes such as ceresin. All of said materials, whatever their specific composition, were more or less plastic in character. That is, they were capable of receiving and retaining an impression from a mold, though when cooled to ordinary temperatures the ordinary sound-record materials were somewhat brittle in character and liable to be shattered in falling from a vertical to a horizontal position on a hard surface. The plasticity of the material employed prior to the date of Edison's 1892 patent is set forth, for example, in Edison's patent No. 382,417, heretofore referred to, it being stated in lines 63 and 64 that the material is still slightly plastic at a temperature of 100 degrees Fahrenheit. That such material is very hard and brittle when cold appears from a perusal of Edison's patent No. 406,576, Mr. Edison stating that he has found it better "to employ a material which is hard and brittle" at ordinary temperatures, and states that such preferable material is a metallic soap, such as a stearate of soda.

The high co-efficient of expansion and contraction of such wax-like materials was very well known at the date of the 1892 patent. In his patent No. 382,462, Mr. Edison stated that compounds composed of wax or other types of hydrocarbon "contract or expand under variations of temperature to a much greater extent than paper, wood, metal and other hard substances," and in his patent No. 393,462, Nov. 27, 1888, he describes a blank made entirely of wax or wax composition, and states (p. 1, ls. 16-19) that:

> "The excessive contraction of the wax in cooling makes it impossible to give such blanks the precise size externally and internally that they should have."

The "excessive contraction of the wax in cooling" is also referred to in Mr. Edison's patent No. 393,463.

In addition to the patents mentioned above, as disclosing the employment of wax-like compositions, I would also call attention to Mr. Edison's patents No. 400,648, No. 400,649, and No. 400,650, all dated April 2, 1889.

From these patents to which I have referred, it will be apparent that at the date of the 1892 split-mold patent of Mr. Edison's, the employment of various wax-like compositions, and particularly metallic soaps and mixtures of saponified stearic acid and ceresin or other tempering wax, was well known; also that such materials were of a hard, brittle nature at ordinary temperatures, but capable of being rendered plastic by the application of heat; and, lastly, that such material possessed a large co-efficient of expansion and contraction, this being so great, in fact, that Mr. Edison himself characterized it as "excessive." This expansion and contraction of waxes and wax-like material was so great, and so well known, that it was taken advantage of to produce a shrinkage in molded materials which had practically no co-efficient of expansion and contraction. For example, when Mr. Edison undertook to make phonogram blanks from asphalt, which, when melted and poured into molds, does not contract in hardening and therefore could not be readily drawn from the mold, he mixed with the asphalt a small percentage of wax, thereby forming a compound "which shrinks slightly in hardening and can therefore be readily removed from the mold" (Edison's patent No. 406,576, p. 1, lines 64-79). It thus appears that by the addition of a very small per cent. of wax to his asphalt he was able to obtain a shrinkage, due entirely to the wax, which shrinkage was sufficient to enable him to readily withdraw the molded blank from the mold. This, I think, is of itself sufficient to demonstrate the fact that it was obvious to experts in the art with which we are dealing that the "excessive contraction" of wax-like material would enable it (after it had been melted and cast into a mold having a record in relief thereon), to be readily withdrawn from the mold upon cooling.

Adjourned to Mar. 23, 1904, at 10:30 A. M.

Washington, D. C., March 23, 1904.

Met pursuant to adjournment.

Parties present as before.

Q. 9. What do you understand to be the meaning of the word "phonogram," as employed in the patent in suit?

A. As employed in the patent in suit "phonogram" means a record tablet either with or without irregular lines corresponding to sound waves thereon. This word is one which, so far as I am informed, was introduced into the art by Mr. Edison and is not to any very great extent employed by those other than Mr. Edison or individuals closely connected or allied with him. Usually in the art, the word "record" is employed to designate a tablet having a record-groove formed thereon, and the word "blank" is employed to designate a tablet prepared for the reception of a record before the record has been formed thereon. In the patent in suit, however, Mr. Edison employs the word "phonogram" sometimes in the sense of a blank tablet, as, for example, in claim 13, where he speaks of introducing the blank within the previously formed matrix as "introducing the continuous cylindrical phonogram to be reproduced within said matrix or mold, in expanding said phonogram into engagement with the record in relief," etc. Here it is perfectly evident that he uses the word "phonogram" in the sense of a blank tablet. In the first two lines of the claim, as well as in the first two lines of claims 8, 9, 10, 11 and 13, among others the word "phonogram" is also used in the sense of a tablet, and in order to convey the idea that said tablet is to be one with a record formed thereon rather than a blank phonogram, Mr. Edison in each of the claims mentioned adds the expression "having a phonographic record thereon," clearly indicating that the word "phonogram" alone was not in his mind sufficient to convey the idea of a tablet with a record formed thereon, as in this case the words "having a phonographic record formed thereon" would be surplusage. In claim 12, instead of using the expression "introducing the cylindrical continuous phonogram to be reproduced within said matrix or mold," as he did in claim 13, Mr. Edison says "inserting the blank to be reproduced within said matrix or mold." This clearly establishes it in my mind that in many cases in the specification the word "phonogram" means a blank tablet. In claims 2 and 3, however, the word "phonogram" in each case where it occurs means a tablet with the record formed thereon. The object of the procedure defined in these claims is to form tablets having record grooves thereon, and in each of claims 2 and 3 this object is referred to as "the method of producing hollow cylindrical phonograms." In the practice of the method Mr. Edison forms a blank tablet exterior to the mold and then introduces it into the mold. He nowhere discloses in the patent in suit the formation of a blank within the mold and hence if, by the expression "forming a hollow cylindrical plastic phonogram within said mold," we were to understand the formation of a blank within the mold, there would be no foundation for the claim in the disclosure of the specification. If we read the word "phonogram," however, to mean in these claims a tablet with a record formed thereon, we can find a foundation for the expression in the specification because the formation of the record groove upon the blank tablet does take place within the mold and hence I am forced to the conclusion that in claims 2 and 3 the word "phonogram" means a tablet with a record groove formed thereon.

Not only do the claims in the patent disclose the use of the word "phonogram" in the sense of a blank tablet, but this also occurs repeatedly in the claims of the specification as originally filed, where he refers to two kinds of phonograms, one being a blank phonogram and the other being a phonogram having a phonographic record thereon. It is therefore very clear that the word "phonogram" as employed in the patent in suit sometimes means a blank tablet and sometimes means a tablet with a record thereon.

Q. 10. The carton of complainant's molded record offered as an exhibit in case 1076 between the same parties involved in this suit is marked "Patented: May 8, 1888, April 2, 1889, November 12, 1889, June 17, 1890, October 10, 1892, February 5, 1901, June 11, 1901, October 1, 1901." Please state, if you can, to what class of articles the first four of the patents mentioned relates?

A. Each of the four patents granted to Edison under the dates named relates to a blank tablet. The patent of May 8, 1888, is the Edison patent No. 382,417; that of April 2, 1889, is the patent No. 400,648; that of November 12, 1889, is the Edison patent No. 414,761, and that of June 17, 1890, is the Edison patent No. 430,274. The claims of all of these patents are specifically limited to "phonogram blanks," and there is nowhere in any one of said patents even a suggestion that they in any way relate to tablets having a record formed thereon.

Q. 11. What bearing, if any, would the fact that complainant marks its molded records as being made under patents which relate solely to phonogram blanks have upon your interpretation of the patent in suit and of the disclosure found in the patent No. 382,417 to Mr. Edison?

A. In my discussion of the Edison patent No. 382,417, I pointed out that the method of procedure disclosed by said patent was the same method, whether it be employed in the manufacture of a phonogram blank, as stated in the patent, or in the manufacture of a record, and this position of mine is amply confirmed by the fact that complainant marks its molded record as being made under a phonogram blank patent, viz., patent No. 382,417. In my opinion the complainant is perfectly justified in marking its molded records as being made under this patent, because in making its molded records it follows the precise steps of the patent No. 382,417. That is, it first forms a blank, as by casting it in the manner shown in Fig. 1 of said patent; it then takes said blank, inserts it in a continuous cylindrical mold, and proceeds to give it the precise form desired while in a plastic condition due to heat, by expanding it outward into intimate contact with the interior surface of the mold by means of a tapering plunger, and, as I have heretofore stated, the tablet must, of necessity, be withdrawn by contracting it through a reduction of temperature and then lifting it out by a direct longitudinal movement. This is an operation in its entirety identical to that defined in claims 2 and 3 of the patent in suit and is in no wise a different operation or method when it is resorted to for the production of a blank from what it is when it is employed for the production of a record.

This marking of the molded records by complainant as being made under patents which are specifically limited to the manufacture of phonogram blanks also confirms me in the opinion which I have heretofore expressed to the effect that the invention of the patent in suit is limited to a process wherein a solid body or blank is introduced into the mold in contradistinction to casting a molten material into the mold. Since the article of the four patents named, *i. e.,* a blank, would be employed in one instance where a solid blank is introduced into the mold, but would not be employed in the other instance when molten metal is cast into the mold.

The fact that complainant marks its molded records as being made under patents pertaining exclusively to phonogram blanks, also confirms me in my opinion that the manufacture of phonogram blanks and phonogram records are so analogous that anyone skilled in the art would readily apply a method for making a blank to the manufacture of a record.

Q. 12. Please compare defendant's said process with that of claims 2 and 3 of the patent in suit, and state whether defendant's process employs the subject-matter of said claims. Please consider in your answer Mr. F. L. Dyer's views on this subject as given in his deposition?

A. Defendant's process consists in coating a wax record with plumbago, electroplating the same, removing the wax record from the electroplate, and backing the electroplate up with a brass shell; casting molten material, consisting mainly of saponified stearic acid tempered with ceresin, into said mold, and then superheating the material and mold, the degree of temperature being raised to a point where the wax-like material becomes perfectly limpid, whereby the material comes into intimate contact with the entire surface of the mold, and then suddenly chilling the mold and the contained material. This chilling of the material produces a contraction of the mold and the material, but by reason of the fact that the co-efficient of expansion of the wax-like material is greatly in excess of that of the metal of the mold, the record shrinks away from the interior surface of the mold sufficiently to entirely clear the surfaces of the mold and permit the molded duplicate record to be lifted out of the mold without injury to the same.

Both of the claims of the patent in suit are limited by the disclosures in the specification and by the prior art, to the formation of a duplicate record therein by the introduction of a solid blank tablet within the mold and then pressing the surface of the tablet against the mold by expansion due to heat, preferably aided also by the introduction of a tapering mandrel. The heating of the solid blank tablet not only serves to expand the tablet but also serves to render it somewhat more plastic than when at normal temperature, so that when it is pressed against the surface of the mold it more readily takes the impression thereof. According to the method defined in the claims, after the tablet has been thus pressed against the surface of the mold and receives the impression thereof, it is contracted by a reduction of temperature sufficient to cause the record to entirely clear the surfaces of the mold, after which it is withdrawn from the mold by a direct longitudinal movement.

The distinguishing characteristic of the method defined in claims 2 and 3 of the patent in suit is the pressing of the solid material against the surface of the mold. This defendant does not do in the manufacture of its records. On the contrary, it casts molten material into the mold, subsequently heating it to a high degree (350 to 375 degrees F.). It will thus be seen that defendant in its process does not employ the step of pressing a solid material into contact with the surface of the mold. In other words, it does not employ that step whereby, according to the specification, the invention of the patent in suit is attempted to be distinguished from the prior art. Defendant does not expand a blank into contact with the interior surface of the mold, and this is the essential feature of the alleged invention set forth in the patent in suit, and particularly insisted upon by the applicant during the prosecution of the case in the Patent Office, as being its distinguishing characteristic.

Complying with that portion of your question which requests me to consider Mr. Dyer's views on this subject, as given in his deposition, I would refer to that portion of Mr. Dyer's deposition beginning on page 24 of complainant's record, wherein he compares the method practiced by defendant with that set out in claims 2 and 3 of the patent in suit. Mr. Dyer says:

> "In order that a comparison may be made between the process of the patent in suit and that actually carried out by the defendant, I will briefly summarize the points of similarity between the two:
>
> First, in both cases an original or master record which is to be duplicated is first formed by the engraving action of a curved edge cutter actuated directly by the original sounds;
>
> Second, this master record in both processes is then coated with an extremely thin film of conducting material in a finely divided condition.
>
> Third, the master so coated is then in both processes electroplated with copper, and the electroplated master is then enclosed in a suitable jacket so as to complete the matrix or mold;
>
> Fourth, the master is then removed from the matrix or mold, the latter, in complainant's process, having already a coating of gold to prevent oxidization, and in defendant's process being subsequently gold-plated for the same purpose;
>
> Fifth, in both processes, a hollow cylindrical phonogram or duplicate copy of the original record is formed in this mold by causing a

> suitable wax-like material in a heated condition to take an impression from the mold, and in both cases when this impression is taken the duplicate is supported internally by a solid metallic core or mandrel;
>
> Sixth, in both processes, the duplicate copy so obtained is permitted to chill until a sufficient radial contraction takes place to separate the engaging surfaces;
>
> Seventh, in both processes, the duplicate is directly removed from the mold after the surfaces have cleared sufficiently to permit of such removal."

The first four of these alleged points of similarity relate to steps followed in the construction of the matrix or mold, and were all well known and practiced in the art long prior to the date of the patent in suit, with the single possible exception of the application of the gold plate to the interior of the mold, and this is not made a part of the subject-matter of the claims 2 and 3 of the patent in suit. As to the fifth alleged point of similarity, I have already pointed out that in complainant's method a solid blank is pressed against the interior surface of the mold, whereas in the method followed by defendant a molten material is poured into the mold. These two steps are radically different, and the method of claims 2 and 3 of the patent in suit is necessarily limited by the description of the invention contained in the specification and by the prior art, to the formation of the phonogram by the pressing step.

As to the sixth and seventh alleged points of similarity, I have heretofore pointed out in my deposition that they were both old and well-known in the art long prior to the date of the patent in suit.

Referring to the conceded difference which I have pointed out in connection with the alleged fifth point of similarity, *i. e.*, the difference between the pressing and the casting step, Mr. Dyer states that this is not of any importance since one is clearly suggestive of the other. With this opinion I cannot agree. The difference is, in my opinion, a very material one. The casting method is simpler, cheaper, and produces a better duplicate. Moreover, if Mr. Dyer's position to the effect that the casting and the pressing step are substantial equivalents be regarded as correct, then there would be no difference between the patent in suit and Mr. Edison's prior patent, No. 667,662, except in scope. The inventions would be the same.

For the reasons given, I am clearly of the opinion that defendant does not practice the method disclosed in the patent in suit and defined in claims 2 and 3 of said patent, when such claims are construed, as they must be, in the light of the specification and the prior art.

> Counsel for defendant offers in evidence printed Patent Office copies of the specifications and drawings of the following U. S. Patents: Edison No. 382,462; Edison No. 393,463; Edison No. 400,648; Edison No. 400,649; Edison No. 400,650; Edison No. 414,761.

Direct examination closed.

Washington, D. C., March 31, 1904,
10:30 A. M.

Met pursuant to adjournment.

Parties as before.

Mr. Dyer proceeds with the Cross-Examination of MR. CAMERON:

> Complainant's counsel says that the direct-examination having by consent been taken without his being present, and his right of objection having been reserved, he now objects to the introduction of Edison's patent No. 667,662 as a part of the prior art, on the ground that the same is immaterial and irrelevant.

x-Q. 13. Do you regard Edison patent No. 667,662 as a part of the prior art?

Objected to as incompetent.

A. Edison's patent No. 667,662 was issued prior to the patent in suit and in the prior part of my deposition I have considered the disclosures therein made wherever they seemed pertinent to the questions being discussed without undertaking to determine whether or not in point of law the Courts would hold such patent as, or as not, a part of the prior art.

x-Q. 14. Your deposition appears to be based upon the proposition that patent No. 667,662 is a part of the prior art. Do you wish it to be so taken?

A. I am not aware that the statement to the effect that my deposition appears to be based on such proposition is entirely correct. As stated in my last answer, when I referred to Edison's patent No. 667,662, issued prior to the date of the patent in suit, I did so because same appeared to me to be pertinent to the particular point under discussion and my only "wish" in the matter is that the Court shall take such view of the question as to whether or not it is a part of the prior art as to the Court may seem proper. In other words, I have no particular wish as to how the Court shall determine this question, which appears to me to be a question of law, and I have not "based" my deposition upon any assumption one way or the other as to this question.

x-Q. 15. What do you regard as the relation between the patent in suit and Edison's patent No. 667,662?

A. No. 667,662 is for a casting process, and the patent in suit is for a process which, in my opinion, necessarily excludes the casting of molten material in a mold and is limited to the expansion of a solid blank of material to take the impression from the mold. Thus far I should regard them as being for different specific methods of making duplicate records. Complainant's expert, however, has held that the patent in suit, and particularly claims 2 and 3 thereof, are broad enough to include the casting of molten material as well as the expanding of solid material. If this view is correct, then, in my opinion, patent No. 667,662 and the patent in suit are for the same thing or the same invention, the only difference being as to the breadth or scope of the claims defining the invention.

x-Q. 16. If complainant's expert is right, the two patents occupy the well-recognized status of broad and specific patents based upon different specific disclosures. Is that correct?

A. No, sir, for if the step of melting and pouring into the mold of molten material is the equivalent of inserting a solid blank and expanding it into the mold, then the two patents are for the same thing. I may add, however, that in my opinion the casting of the molten wax and the expansion of a solid blank are specifically different, and are not equivalent steps.

x-Q. 17. Assume that complainant's expert referred to casting as the "equivalent" of expanding, so far as claims 2 and 3 of the patent in suit are concerned, in the sense that Judge BLATCHFORD found the subsequently patented elements of the Lancaster machine the equivalent of the elements of the Morley machine, in Morley *vs.* Lancaster, 129 U. S., 263. Under this assumption cannot you endorse the proposition of my last question?

> Objected to as immaterial, and as indefinite, there being nothing to indicate what is meant by the sense that Judge BLATCHFORD employed in the decision referred to in question. Defendant's counsel respectfully submits that the witness is not called upon to read and interpret a decision of the Supreme Court.

> Complainant's counsel replies that the witness qualified as a lawyer and gave a direct deposition, which is a lawyer's rather than an expert's discussion. Witness is not called upon to interpret the decision, but only to make the assumption that complainant's expert used the term "equivalent" as including subsequently patented means to effect the same result.

A. I would not undertake to answer this question without reading the decision in Morley *vs.* Lancaster, a decision which I have not perused for several years.

x-Q. 18. Have you ever examined the molded records put out by the complainant?

A. I have seen molded records put out by the complainant, and have examined one or two of such records somewhat carefully, but I have never made an exhaustive examination of any great number of such records.

x-Q. 19. Have you read the testimony of Edison, Aylsworth and others in this case, explaining how the complainant's molded records are made at the present time?

A. I have.

x-Q. 20. Complainant's molded record is carried by a cylinder, or is a cylinder, constructed wholly of wax-like material and having the same co-efficient of expansion throughout its mass?

A. The record commercially put out by the complainant is one, so far as I have seen such records, composed of a cylinder of wax-like material. I should, without having actually tested the same to ascertain the fact, expect to find that it had the same co-efficient of expansion throughout its mass.

x-Q. 21. Complainant's molded record is also a hollow cylinder having a tapering bore to fit the mandrel of the phonograph?

A. It is a hollow cylinder and all of those I have ever placed upon the mandrel of a machine were tapered to fit the mandrel.

x-Q. 22. Have you any doubt as to the fact that complainant's molded record embodies the terms of the claims of Edison patent No. 382,462, referred to in your direct examination?

A. I should presume that it would respond to the terms of all three of the claims of this patent, though I am not informed whether or not the coefficient of expansion is the same throughout its mass.

x-Q. 23. Have you any doubt as to the fact that complainant's molded record embodies the terms of claims of Edison patent No. 382,418, granted May 8, 1888?

A. All of complainant's records that I have become familiar with would respond to the terms of the claims of this patent.

x-Q. 24. The process by which complainant's molded records are made does not respond to the terms of the claims of Edison's patent No. 382,417, even if the words "blank" and "blanks" in those claims were replaced by the words "record" and "records"?

A. I cannot say, since I do not know the particular method employed by complainant in making its records.

x-Q. 25. It appears in the case that the particular method employed by complainant is that of the Miller & Aylsworth patent No. 683,615. Please answer the last question with this understanding?

A. The process described in the Miller & Aylsworth patent is a "dipping" process. That described in the Edison patent No. 382,417 is a "pressing" process. As I understand the Miller & Aylsworth process, it does not respond to the terms of the Edison patent.

x-Q. 26. You understood at the time of giving your direct deposition that complainant's molded records were made in accordance with the specific process described in the Miller & Aylsworth patent referred to? I call your attention to answers 33 and 34 of the deposition of W. H. Miller, in this case, given for complainant.

A. I understood that complainant claimed to make its commercial records under the Miller & Aylsworth patent, and I was familiar with that part of Mr. Miller's testimony wherein he says that they did so make it.

x-Q. 27. Where did you get the information which enabled you to make the positive statement of your answer to Q. 10 that the patent date of May 8, 1888, which appears on the cartons carrying complainant's molded records, "is the Edison patent No. 382,417"?

A. I have in my possession, chronologically arranged, a practically complete set of patents granted in the talking machine art, and by referring to the patents granted on May 8, 1888, I find granted to Edison on that date the patent No. 382,417. There were other patents granted to him upon the same date which were for mechanism in connection with phonographs, and could not therefore be referred to as the patent of May 8, 1888, under which complainant's records are made. I find, however, upon again referring to the patents granted upon that date. viz., May 8, 1888. that there were two other patents granted to Edison upon that date, viz., patent No. 382,418 and 382,462, which might have been referred to under the date of May 8, 1888, found on the carton, and to that extent my statement that the patent No. 382,417 is the one that must have been referred to is an error.

x-Q. 28. You have not yet made it clear why in making your selection of patents intended to be referred to by the patent dates marked on the cartons containing complainant's molded record, you selected an Edison patent of May 8. 1888, describing and claiming a process which you *knew* was not employed in the manufacture of complainant's molded record, and omitted to select two other patents to Edison of the same date, viz., Nos. 382,418 and 382.462, which you *knew* described and claimed inventions embodied in complainant's molded record, one of which patents, viz., No. 382,462, you had before you and referred to in another connection in your direct examination, and the other patent, viz., No. 382,418, immediately follows the patent you did select in your chronologically arranged set?

A. I must take exception to that part of your question to the effect that I knew or know the process followed by complainant in the manufacture of its records. I might say in passing that I do not know that complainant employs the Miller & Aylsworth process in the manufacture of its commercial records, and, furthermore, I do not believe it does.

The last half of your question I have already attempted to answer. I frankly admit that the Edison patent No. 382,418 would be applicable to complainant's commercial record, and it is quite possible that the same is true of patent No. 382,462, and I also as frankly admit that in selecting patent No. 382,417 as the one referred to under the date of May 8, 1888, on the carton, I was in error and was led into such error by overlooking the two patents No. 382,418 and No. 382,462.

x-Q. 29. You don't undertake by your testimony in this case to deny the statements of complainant's witnesses familiar with the facts, that the specific process employed by complainant in the manufacture of its molded records is the process of the Miller & Aylsworth patent No. 683,615?

A. I do not; I only stated my belief.

x-Q. 30. In your answer to Q. 11, you make what appears to be a positive statement that complainant in the manufacture of its molded records uses the process of expanding a blank in the mold, and make this statement the basis of an argument unfavorable to the complainant. Is there any testimony in this case supporting your statement?

A. I know of no testimony to the positive fact that in making its records complainant expands a solid blank. That portion of my answer to Q. 11 referred to assumes that complainant's records are made under the patent in suit.

x-Q. 31. That is, you assume that complainant in making its molded records used the process specifically described in the patent in suit, viz., expanding a blank in a mold by means of a tapering plunger. Is that right?

A. I assumed that if the complainant made its records in the manner suggested in your question that it would then bring itself under Patent No. 382,417, and would be justified in so marking the record.

x-Q. 32. Did you make the same assumption in selecting patent No. 382,417 in your answer to Q. 10?

A. Certainly.

x-Q. 33. In other words, notwithstanding that the fact had been established (by testimony of persons knowing the facts) that, in the manufacture of its molded records, the complainant used the Miller & Aylsworth process, you thought that the mentally reserved and unexpressed assumption stated by you in answer to x-Q. 31, warranted you in making the positive statement in answer to Q. 10, that patent No. 382,417 was referred to by complainant in marking its carton with the date May 8, 1888, and the further positive statement in your answer to Q. 11 that complainant was justified in marking its carton with this patent, because in making its molded records it used the process of expanding a blank in a mold by means of a tapering plunger? Is that right?

A. In my answers to Qs. 10 and 11, I made no mental reservation, though I was so far as patent No. 382,417 is concerned assuming that complainant's records are made under the patent in suit.

Recess.

x-Q. 34. You say in substance that the leading thought in the patent in suit, distinguishing it as a departure from Edison's patent No. 484,582, is the "pressing" as distinguished from the "casting" operation in forming the record. Do you not also recognize as an equally important thought in the patent in suit, distinguishing it over Edison's earlier patent, the idea of using a continuous mold, and the removal of the record from the mold by first contracting it radially and then withdrawing it by a direct longitudinal movement?

A. I do not.

x-Q. 35. I am not now asking you whether you regard these differences as amounting to invention. I appreciate your attitude with respect to that matter. What I want to know is, if you do not recognize the fact that the patent in suit, as a document or in terms, distinguished over the earlier Edison patent, not only with respect to the manner of forming the record, but also in respect of the manner of removing it from the mold.

A. The 484,582 patent, while it suggests the use of a split mold, does not exclude the use of a continuous mold; and, on the other hand, while the patent in suit describes a continuous mold and does not specifically describe the use of a split mold, it does not exclude the use of a split mold. The 484,582 patent clearly discloses a continuous mold and the only claim thereof which defines the process of making duplicate records is not limited to the employment of a split mold, but can as well be carried out with the continuous mold disclosed in the specification of said patent. And if a duplicate is thus molded in the continuous mold disclosed in said patent, it will be perfectly obvious to anyone skilled in the art that the only way in which it could be removed from the mold would be by contracting it radially until it cleared the surfaces of the mold and then withdrawing it by a direct longitudinal movement. I think, therefore, that the radial contraction and direct longitudinal withdrawal of the duplicate from the mold, defined in the patent in suit, is not one of the features which distinguishes it from the earlier Edison patent No. 484,582.

x-Q. 36. I am asking about the *terms* of the two patents. Does the earlier Edison patent describe in *terms* the radial shrinking of the record to clear the surfaces and the withdrawal of the record from the mold by a direct longitudinal movement?

A. No, it does not, but the radial contraction of wax-like material which, as Mr. Edison states, is "excessive," was so well known to those skilled in this art that it would be perfectly obvious to such skilled operator that, if the record were cast in the continuous mold disclosed in this patent, the direct longitudinal withdrawal of the molded record would be easy.

> The answer after the first four words is objected to as irresponsive.

x-Q. 37. Now, as a matter of terms, you must of course assent to the proposition that the patent in suit asserts that one of the features of the invention covered by it is the method of removal of the finished duplicate from the mold?

A. It does.

x-Q. 38. In interpreting the phrase "forming a hollow cylindrical plastic phonogram within said mold," appearing in claims 2 and 3 of the patent in suit, did you take into consideration the interpretation of these claims given by the Patent Office before the patent issued by declaring an interference with the application of Joyce, describing a "casting" process?

A. I know that there was an interference with an application of Joyce's, but I have never seen this application, and in interpreting the phrase referred to I could not, therefore, base any material part of my interpretation of it upon the alleged disclosure of the Joyce application, and did not do so.

x-Q. 39. I notice in your answer to Q. 3 that you refer to the Miller & Aylsworth No. 683,615. Is your deposition based upon the assumption that that patent is a part of the prior art?

A. I cannot say that it is "based" upon any such assumption. I merely referred to it in my deposition because it appeared to be pertinent at the particular point, and in connection with the particular subject-matter which I was then discussing.

x-Q. 40. You refer to Edison's patents 484,582 and 667,662 as "prior" patents, and you also refer to the Miller & Aylsworth patent in the same connection; and you reach the conclusion that the patent in suit "appears to be based wholly upon the difference between *casting a molten material* into the mold and introducing therein a *solid blank* which is *expanded* into close contact with the surface of the mold." Is this conclusion based upon the disclosures of these three prior patents?

A. My conclusion is based upon the disclosure made by the descriptive part of the patent in suit and the position taken by the applicant himself during the prosecution of the case in the Patent Office. In the patent itself it is clearly and specifically pointed out that in carrying out this process applicant does expand a solid blank into contact with the surface of the mold for the purpose of taking an impression therefrom, and no other method of procedure is indicated. Furthermore, in the prosecution of his application in the Patent Office, applicant clearly indicated that his invention was not broad enough to include the use of a solid blank which was "displaced" to cause it to take the impression of the mold, specifically contrasting the *expansion* of a solid blank with what he called the *"displacement"* of a solid blank. From the fact that the patent itself discloses nothing but the method of expanding a solid blank, and the further fact that the applicant stated that his "invention" was not broad enough to include, and did not include the formation of a hollow cylindrical plastic phonogram within the mold by another specific process, viz., that of displacement, I was led to the conclusion that the patent in suit was based wholly upon the expansion of a solid blank within the mold as distinguished from the formation of said blank within the mold by any other specific step, and particularly that it distinguished from casting molten material within the mold which is a step further removed from that of expanding a solid blank, than is the step of displacing a solid blank within the mold. Applicant's distinction between "expanding" and "displacing" was a very narrow one, viz., his allegation that in "expanding" the blank acted like an india-rubber band—first stretching outward and then contracting inward, whereas by "displacement" he alleged that the blank was first caused to move bodily outward against the mold and did not thereafter contract as a rubber band would do. This to my mind is a very narrow and technical distinction, but is one upon which the applicant relied to differentiate the invention of the patent in suit from certain patents in the prior art which had been cited against him. The foregoing were the reasons which lead me to my conclusion that the patent in suit was based upon the distinction of expanding the blank, and I relied more upon them than upon any reference to the prior art.

x-Q. 41. Following the conclusion quoted in the last question, you state in your deposition:

> "This appears from the description of the invention in which the only departure from previous practice is in the formation of the record by the expansion of a solid blank within the mold."

Do you there refer to the description contained in the patent in suit?

A. I do.

x-Q. 42. In making this statement, did you not overlook the fact that the patent in suit makes the assertion that one of the features of the invention covered by it is the method of removal of the finished duplicate from the mold? I call your attention to your answer to x-Q. 37.

A. I did not.

x-Q. 43. But it is not true that the patent in suit *describes* as the only departure from previous practice the formation of the record by the expansion of a solid blank within the mold?

A. The patent in suit refers to several steps which taken together go to make up the method or process pursued by the patentee in forming a duplicate sound-record. The first of these, viz., the obtaining of a mold, while it is one of the steps of the process, admittedly is not a new step. And the contraction and direct longitudinal movement of the duplicate, while not expressly stated in the specification to be an old step, is one which was old in the art and which being addressed to those who are experts in the art, would be readily understood by such experts as being old. I think that a perusal of all that part of the patent which precedes the claims will clearly establish the statement which I made in my answer to Q. 3, that the patent in suit appears to be based wholly upon the difference between casting molten material into the mold and the introducing therein of a solid blank which is expanded into close contact with the surface of the mold. I did not state, and do not state, that this is the only step in applicant's process, but I do state that it is perfectly apparent that it is the one step upon which the patentee relied in his efforts to differentiate his invention from the prior art, and such being the case it is *the* step upon which the patent in suit is based.

x-Q. 44. Since you admit (x-Q. 37) that the patent in suit asserts in terms that one of the features of the invention covered by it is the method of removal of the finished duplicate from the mold, I thought you might be willing to admit that you were in error in making the statement in answer to Q. 3, which appears by that answer to be one of the foundations of your attitude, viz., that the patent in suit *describes* as the only departure from previous practice the formation of the record by the expansion of a solid blank within the mold. Do you decline to make that admission?

A. Your question does not present the statement which I have made in my answer to Q. 3. I stated in that answer that it appears from the description of the invention that the only departure from the previous practice is in the formation of the record by the expansion of a solid blank within the mold. And further along in said answer, in analyzing claim 2 and indicating the four steps of which it is composed, I stated that, in view of the prior art as exemplified by patents in evidence, it is evident that the "method" defined in the claim could be considered a departure from previous methods of molding cylinders of wax-like and other materials, if at all, solely in that part of the method which is defined by the words "forming a hollow cylindrical plastic phonogram within said mold." I further stated that this conclusion was reached by an examination of the specification which points out as the salient feature of the invention, the expansion of a solid blank within the mold. I do not think that my position can be at all misunderstood.

I recognize the fact that the removal of the record by a direct longitudinal movement is described in terms in the specification, as well as other steps involved in the method, but I repeat that the salient step in the method, and the one upon which the invention of the patent in suit seems to be based, is the step of expanding a solid blank within the mold, and I do not think that I was in error in so stating in my answer to Q. 3.

x-Q. 45. You have repeated in your answer just given, in the second sentence thereof, the statement which I regard as an error. Do you still decline to make the admission asked for by x-Q. 44?

A. I do.

x-Q. 46. Referring to the use of the word "plastic," in claims 2 and 3 of the patent in suit, do you not recognize the fact that that word may refer to the character of the material of which the phonogram is made rather than to the process of forming the phonogram. *i. e.,* that the word "plastic" qualifies the word "phonogram" and not the word "forming"?

A. The word "plastic" is not used anywhere in the specification of the patent in suit, but as used in claims 2 and 3 thereof I should understand it to mean to modify, or indicate a characteristic of, the material in which or upon which the record groove was to be formed, *i. e.,* that the expression "forming a hollow cylindrical plastic phonogram" when read in the light of the descriptive matter of the specification and of the prior art, means the formation of a record groove upon a body of material which, at the time of its formation, is in a condition to receive an impression from the mold and retain such impression. I should therefore understand the word "plastic" as modifying or defining the kind of material in or upon which the record groove was to be formed. With the record groove formed in or upon the plastic material, we should have a plastic phonogram, and to this extent the word "plastic" *might* be considered as modifying the term "phonogram."

x-Q. 47. The word "phonogram" as used in these claims means the completed cylinder carrying the record?

A. I think so. Though Mr. Edison is not always perfectly accurate in his use of this word, since he himself sometimes uses the word to indicate a blank cylinder for the reception of the record groove, and in fact did do so in the application as originally filed, which resulted in the patent in suit. Nevertheless, in claims 2 and 3 of the patent in suit, I am inclined to construe the word "phonogram" as meaning solid material having record grooves formed thereon or therein.

x-Q. 48. And hence "plastic phonogram" as used in these claims means such a completed cylinder carrying the record made of a plastic material?

A. It is very difficult to say with absolute certainty, but I am inclined to agree with complainant's expert. Mr. Dyer, in his opinion that a plastic material means a material "having a quality of receiving and retaining impressions." (Dyer's deposition x-Q. 71). And since the only object in having the material "plastic" would be to have it in condition to receive the record impression from the interior of the mold, I am inclined to the opinion that the term "plastic" as used in these claims refers to the condition of the material at the instant when it receives the impression from the mold. In other words, I understand that the material at such instant must be in condition to receive and retain the impression of the mold without regard to the fact as to whether or not it retains this condition after the operation is completed. x-Q. 49. Do you not think a possible interpretation of "plastic phonogram" as used in these claims, is that it means a phonogram of plastic material, or material capable of being made plastic by heat, irrespective of the method of forming the phonogram?

A. It is, of course, "possible" to so construe the word "plastic," since it appears that you have already done so. In my judgment, however, this cannot properly be done without doing violence to the whole object of the invention of the patent in suit. There could be no possible object of having a completed sound-record or "phonogram" in a condition capable of receiving and retaining an impression. In fact, the further we can get away from such condition after the record is once formed, the better the record will be. There is, however, a very distinct object in having the material in a plastic condition, *i. e.,* in a condition capable of receiving and retaining an impression, at the time when it is brought in contact with the surface of the mold in practicing the specific invention set out in the patent in suit, and I am therefore led to the conclusion that when the patentee used the term "plastic" he meant a material for the reception of an impression which material was in a condition capable of receiving and retaining the impression of the mold.

x-Q. 50. Perhaps the difference between us is only a matter of words. I might agree with you that plasticity in the completed article is not particularly desirable, and yet believe that the quality of plasticity in the material of the completed article is the quality which permits the material to be softened by heat, even to the form of liquid, so as to practically enable it to take and retain an impression from the mold. Believing this, and seeing that the grammatical form of the words used in claims 2 and 3 requires that "plastic" should be regarded as modifying "phonogram," my view is that "plastic phonogram" means the plastic quality of the material of which the phonogram is made, irrespective of the method of forming the phonogram. Do you not recognize this as a reasonable interpretation of the language?

A. I do not, since it appears to me that the reasonable interpretation should be one based upon the objects of the inventions disclosed, the use to which the finished article is to be put, and the particular steps employed in the formation of that article. These all point, in my judgment, to that meaning of the word "plastic," which would limit it to a modification of, or definition of, the condition of the material at the time when it is brought into contact with, or impressed against the surface of, the mold, since that is the time when it is of essential importance that the material should be in a condition capable of receiving and retaining an impression.

x-Q. 51. In casting a phonograph record from wax-like materials, such as defendant uses, when does the material receive and retain the impression of the mold?

A. I should not regard it as strictly correct to say that it received the "impression of the mold at all. The material enters the mold in a molten condition, and upon reduction of temperature it returns to the solid condition, and in such solid condition has an exterior formation responding to that of the pattern on the interior of the mold which, in the instance under consideration, is a sound-record. I should regard the receiving of "the impression of the mold" as the result of bringing the material into contact with the mold by *pressure*, so that in my judgment it is rather a loose use of the word "impression," to apply it to the act of casting a molten material into a mold and allowing it to solidify therein.

x-Q. 52. You say that in cooling down from the melted to the solid state in the casting process, the material of course passes through all intermediate degrees of plasticity. While the material is still a liquid, it could be poured out of the mold and have no form?

A. That is correct.

x-Q. 53. At what stage of the cooling down, and at what degree of plasticity, would the material be given form?

A. In passing from the liquid to a solid state, some material congeals suddenly and others taper off, so to speak, from the liquid through a soft, non-coherent and jelly-like condition, into the more solid condition I should regard the material as reaching a plastic condition only when it reached that degree of solidity which would enable it to maintain its own form after removal from the mold. It would be given form at that state of the cooling down where it became sufficiently solid to receive and retain impressions. As to "what degree of plasticity" this would be, I am unable to say.

x-Q. 54. With such materials as defendant uses in its casting process, the material would be plastic at the time it is given form?

A. At the first instant when it can be said to receive form from the mold, I doubt whether it would be in a condition to retain its form if deprived of the support of the mold, but it certainly would be in a very few moments of time thereafter if the lowering of the temperature and the solidifying of the material continued.

x-Q. 55. When the material passes from the condition of a liquid in which it might be poured out of the mold to such a solid condition that it could not be poured out of the mold, it has become plastic?

A. Perhaps, to a degree, but I can readily conceive that the material might reach a condition where it could not be "poured out of the mold" and yet if the interior core were removed it might gradually flatten down within the mold. In other words, would not have consistency sufficient to maintain its own form, even though it might not be capable of being poured out of the mold.

x-Q. 56. When the material first reaches the condition where it will retain its form, if deprived of the support of the mold, it is then plastic?

A. Yes, sir.

Adjourned to Friday, April 1st, 1904, at 10 A. M.

Washington, D. C., April 1st, 1904, 10 A. M.

Met pursuant to adjournment.

Parties as before.

Mr. Dyer continues the Cross-Examination of Mr. CAMERON.

x-Q. 57. Regarding Edison's patent 382,417, does this patent contain any statement that the blank after being pressed in the highly polished die of speculum metal, is allowed to cool and contract before it is withdrawn?

A. No, sir. This patent, however, is addressed to those skilled in the art and one skilled in the art would know that the only way in which the blank could be removed from the highly polished die of Fig. 3 after it had been forcibly expanded against the surface of such die, would be by taking advantage of what Mr. Edison calls the "excessive" contraction of the wax-like material upon cooling.

x-Q. 58. Do you think there would be any difficulty in drawing the blank out of the die immediately upon the completion of the pressing operation?

A. The patent does not state whether the die is employed in a cold or a heated condition, as I now recall, and the assumption is that the temperature of the die is that of the atmosphere, which would be approximately 70 degrees. The blank is said to be inserted in the die at a temperature of about 100 degrees F., and the necessary result of pressing the blank in the polished die would be to cool the material somewhat, but would not permit it to contract or draw away from the die while the tapering mandrel was in the blank. In my opinion, the blank might be removed from the die very shortly after the tapering mandrel is withdrawn, since the cooling of the blank would require but a very short time to enable its "excessive" contraction to withdraw it from contact with the polished surface of the die.

x-Q. 59. Did you ever try the experiment described in connection with Fig. 3 of this Edison patent?

A. No, sir.

x-Q. 60. Would you be surprised to learn that with a highly polished die of speculum metal the blank can be immediately withdrawn after pressing and before any material contraction or reduction in temperature takes place?

A. With a very highly polished die, any reduction in temperature, though small, would be material and would result in some contraction of the blank which would be material. I should certainly not expect that the blank could be removed from the die without any reduction of temperature, or contraction of the blank.

x-Q. 61. Assume that the highly polished die was given a slight taper; would any reduction of temperature, or contraction, be necessary to enable the blank to be withdrawn?

A. A slight taper to the die would certainly enable the blank to be withdrawn much more easily, and possibly without reduction in temperature.

x-Q. 62. Considering the thing theoretically (since you have not made the actual experiment), would not the giving of the die a slight taper enable the blank to be withdrawn without any contraction whatever, in view of the highly polished character of the die?

A. Yes; but in that case the product would not be the product which Mr. Edison says in the patent he prefers to use, viz., "a hollow tapering *cylinder.*" If the resulting blank is to be a "cylinder" it cannot be made in a tapering die. It may, however, have an interior opening which would taper, as would necessarily be the result of employing the tapering plunger G. The die shown in the patent, Fig. 3, is not a tapering die, whereas the Plunger G which is inserted into the blank, is a tapering plunger. By employing this tapering plunger and cylindrical die a blank would be obtained which would perfectly respond to the form that Mr. Edison says he prefers, viz., "a hollow tapering cylinder," though he also says that the invention is applicable to other forms. The apparatus disclosed in Fig. 3 would give a blank cylindrical on its exterior surface, and having a tapering hollow or interior opening to fit the tapering mandrel found on all standard talking machines using the cylindrical records. That the blanks do contract, and materially contract, upon cooling to such an extent in fact that though the patent 382,417 was designed to form a blank "accurate in its size" both "externally and internally," it was found that the blank contracted so much upon cooling that it had to be reamed out after cooling to give it the proper size to fit the tapering mandrel of the Edison phonograph. In his patent 414,761, Mr. Edison says, lines 59 to 64,

> "In the process of molding the blank *while the material cools* it sometimes becomes contracted or warped on its inner surface, so that it does not fit the phonogram-cylinder, and in this case it has to be reamed out to remove the irregularities. This has to be allowed for in making the blanks."

I think this clearly indicates that Mr. Edison found when he made his blanks in accordance with, or by the use of the apparatus shown in, patent 382,417, that, by reason of the contraction of the blank, he did not get that exact size both externally and internally that was necessary, at least the exact internal size that was necessary, and he was forced to make allowance for the contraction and then ream out the blank after it had cooled and contracted.

x-Q. 63. Is it not a common expedient in casting or molding articles, particularly in metal molds, to give the molds a slight taper so that the articles can be readily "drawn" from the mold?

A. It is.

x-Q. 64. Do you not observe that in patent 382,417 the word "cylindrical" is used somewhat loosely, as in the expressions "tapering cylindrical blanks" (l. 17) and "cylindrical phonogram carrier" (l. 84), the latter being well known to be a tapering form?

A. The first expression quoted in your question is not an example of a loose use of the word cylindrical, since the blank made in Fig. 3 would be a perfect cylinder exteriorly and would taper interiorly, thereby having a form which Mr. Edison, in common with other experts in the art, has recognized as the ideal form for a recording tablet. In fact, on this same date, viz., May 8, 1888, Mr. Edison took out a patent, 382,462, claim 3 of which is for a "hollow cylinder with a tapering bore," and Fig. 2 of this patent is an exact illustration of the blank shown in position in Fig. 3 of the patent 382,417. I think, therefore, that in speaking of a "tapering cylindrical blank" in line 17 of the last-named patent, Mr. Edison very clearly and properly described a blank which is a hollow cylinder having a tapering bore. The use of the word "cylindrical" in line 84 of patent 382,417, is not strictly accurate, but was used in such a relation that it very clearly conveyed the intended meaning.

x-Q. 65. I quote from patent 382,417.

> "A tapering plunger, G, pressed forward by a screw, H, is forced into the bore of the phonogram blank, pressing the blank against the walls of the surrounding die, and giving it the exact shape and size, both externally and internally, that it is desired the blank should have."

Is it not evident from this that the mold and plunger of Fig. 3 are designed to have the exact shape and size of the completed blank, and that no contraction of the blank after the pressing operation is contemplated—a result which would be secured by retaining the blank in position in the die with the plunger within it until the blank reached atmospheric temperature?

A. It was evidently Mr. Edison's intention, as expressed in the patent, to give the blank its exact size internally and externally "that it is desired the blank should have." Mr. Edison found, however, as set forth in his patent No. 414,761, to which I have referred, that contraction had to be allowed for in making the blank. Moreover, I observe in lines 77 to 80, of patent 382,417. Mr. Edison first removes his plunger from the interior of the blank and then removes the latter from the die, and he then states that the blank "would be ready for use on a phonograph." If the plunger were permitted to remain within the blank until the blank had cooled, the contraction of the blank would be so great as to split the blank. If, however, the plunger were removed before the blank had cooled, its tapering form would enable this to be readily accomplished, and but a few moments of time would be necessary to further cool the blank and thus so contract it as to enable it to be readily removed from the die, and being thus cooled it would be "ready for use on a phonograph," a condition which would not be practicable if the blank were warm at the time of its removal, since if a warm blank be put upon the cylinder of a phonograph the latter would chill the blank and result in a contraction which would inevitably split the blank. That this splitting of the blank is almost certain to occur when the same is placed upon the tapering cylinder or mandrel in a warm condition, and subsequently allowed to cool, is well known to anyone accustomed to use talking machines employing records made of wax-like material. I have myself, more than once, had records split by placing them upon a tapering mandrel of the machine on a warm evening and neglecting to remove them. The resulting chill of the succeeding night caused such a contraction of the material of the record as to split and destroy it. I think, therefore, that it is evident to anyone skilled in the art that the blank could not have been permitted to cool in the die with the plunger G in position in the blank. One skilled in the art, even if not instructed in Mr. Edison's patent, would readily have understood that the plunger should be removed, and that after a very few moments' cooling at normal temperatures, the blank would then be readily removable from the die by reason of its contraction.

x-Q. 66. Patent No. 414,761 relates to making phonogram blanks by a casting operation, the blanks being finished by turning and reaming and not by pressing in a polished die as in patent No. 382,417?

A. Yes, sir. Mr. Edison found that the pressing in the die of 382,417 did not give him the exact external and internal size desired, because of the contraction occurring when the material cooled.

x-Q. 67. Your authority for the statement as to what Mr. Edison found is based upon the language of patent No. 414,761?

A. My own knowledge of what would occur, based upon practical experiments of my own, would lead me to the conclusion that Mr. Edison must inevitably find that he would not get the external and internal size desired by the process of patent 382,-417, and this conclusion is confirmed by what I find in Mr. Edison's patent 414.761.

x-Q. 68. The method of finishing phonogram blanks by pressing, instead of by reaming and turning, has not, so far as you know, been practiced commercially?

A. Not so far as I am aware.

x-Q. 69. Regarding the Lioret patent, No. 528,-273. do you regard the method of reproducing phonographic cylinders therein specifically described and illustrated as an operative and useful method?

A. I see no reason why it should not be operative as well as useful.

x-Q. 70. Did you observe the criticism of the operativeness of this patent contained in the affidavit of Charles N. Wurth, sworn to Aug. 29, 1898, one of the papers in Defendant's Exhibit, File and Contents of the Patent in Suit?

A. Yes, sir; and I also observed that the Patent Office held that the same was not regarded as sufficient to enable the Office to determine that the processes set forth in that patent and another English patent, were inoperative. The Patent Office said, in its letter of Sept. 15, 1898, in regard to the Lioret process as set forth in his British patent (which is the same process as described in his U. S. Patent referred to in your question):

> "The said processes must be regarded as operative until their inoperativeness is established."

x-Q. 71. Have you ever attempted to carry out the Lioret process?

A. No, sir.

x-Q. 72. Regarding the making of the mold, do you think it would be practically possible to separate the metal deposit from the steel record cylinder, as Lioret describes, without injury to the sound record carried by the deposit?

A. I do.

x-Q. 73. Why?

A. I see no reason why this could not be accomplished. I observe that in his affidavit Mr. Wurth thinks that there would be an "adhesion between the coating and the mold," but this would not occur if the steel cylinder were properly treated before the electro-deposition of the metal was secured. I also observe that Mr. Wurth does not believe that the coating should be expanded by heat so as to separate it from the steel record cylinder "owing to the practically constant co-efficient of expansion of all metals." This would present no difficulty whatever if the operator supplied only sufficient heat to expand the coating, without heating and consequently expanding the steel cylinder. It is a common practice in shrinking one tube of metal upon another of the same metal (as for example in gun making) to heat one tube while the other remains cold, and then place the heated tube over the cold one, after which the heated tube is allowed to cool, when it so contracts that it grips the inner tube very firmly. If we follow the reverse of this operation, and again heat the outer tube while keeping the inner tube cool. the outer tube can readily be so expanded as to remove it from the inner tube.

x-Q. 74. If the electro-deposit was made directly upon the steel record cylinder. would you not expect the deposit to adhere?

A. I understand your question to contemplate the electro-plating of the steel record cylinder without any treatment to prevent the electroplate from adhering thereto. In such case probably the electroplate would adhere to the steel record cylinder, and for this very reason no one who understood his business would think of electro-plating a steel cylinder without previously treating it so as to permit of the ready separation of the electro-deposit from the cylinder.

x-Q. 75. In attempting to expand a celluloid ring into the mold when immersed in water, as described by Lioret and illustrated in Fig. 8 of his patent, would you expect to secure a perfect impression and without imperfections arising from entrapping water in the threads?

A. I should expect some water to be entrapped and to result in some imperfections in the record. I should therefore expect to obtain a record. though not as good a one as might be obtained in case the water was excluded from between the surface of the celluloid blank and the mold. My reason for this opinion that water would be entrapped between the blank and the mold is in the fact that experience has taught that when a solid blank of plastic material, such as the wax-like blank, is inserted into a matrix or mold and then expanded within the mold, even air that is between the inner surface of the mold and the outer surface of the blank will become entrapped and produce more or less imperfections in the resulting duplicate record. This would occur, for example, when using the matrix and blank of the patent in suit. Since experience has taught that air will thus become entrapped, I should expect to find that water would be entrapped in the same way.

x-Q. 76. Does not the peculiar form of the Lioret record make it particularly liable to injury from the entrapping of water in expanding the blank in the mold?

A. I should think that the particular form of the screw-threads, *i. e.,* the depth thereof, might render the water a little more liable to be entrapped than would be the case if the record were on the smooth surface of a matrix, though this is not entirely clear, since it is quite probable that the inclined surfaces leading away from the bottom of the V-shaped groove where the record is situated in the matrix, would result in no water being entrapped at the exact point where the record occurs, the water being forced therefrom along the other surfaces where the record does not exist.

x-Q. 77. Regarding the Young English patent No. 1478 of 1894, do you think that Young was mistaken in stating that it was necessary to collapse the thin cylinder *after* it had been cooled, in order to remove it from the mold?

A. Would you kindly indicate to me wherein Young makes any such statement?

x-Q. 78. I refer to the last line of page 3 and first line of page 4 of the Young patent.

A. I observe that Young states that he is, after cooling, "enabled, by slightly collapsing this (meaning the duplicate) inwardly, to cleanly and easily remove it from the electro." This is far from stating that it is "necessary" to do this. Moreover, I observe that the patent in suit employs the same material, viz., celluloid, that Young employs, and that this is the only material specifically claimed (see claim 18) in the patent in suit, and if it is necessary for Young to collapse his completed duplicate in order to remove it from the mold, then it would unquestionably be necessary for Mr. Edison to collapse a duplicate made of the same material in order to remove it from the same mold.

In this connection it might not be inappropriate to call attention to the well-recognized practice in the Patent Office, requiring an applicant to draw all of his claims so that they will read upon a single specific illustration of his invention, and under this practice, since the specific material claimed in claim 18 is celluloid, we are warranted in the assumption that the Patent Office granted claims 2 and 3 with celluloid in mind as the material of which the hollow cylindrical plastic phonogram of said claims was to be made.

x-Q. 79. Do you not recognize the fact that different processes may be performed in this art with the same material?

A. Certainly, but when the same steps are performed in the same order upon the same material, I do not regard the processes as different processes but as one and the same process.

x-Q. 80. You may assume that when Young said that by collapsing the thin tube he was "enabled" to remove it from the mold, he meant that without such collapsing it could not be so removed? On this assumption as to Young's meaning, do you think he was mistaken about the fact?

A. I should have to base my answer entirely upon my knowledge of the art without ever having undertaken to shrink a celluloid blank away from a matrix, but I should expect that if the celluloid blank were partially cooled that it might be necessary to slightly collapse it in order to withdraw it from the mold; and if it were further reduced in temperature I should expect a further contraction such as would enable it to be withdrawn from the mold without collapsing it. So, in my opinion, it would depend entirely upon the degree of cooling. If only slightly cooled collapsing would be necessary, whereas, if further cooled, I do not think it would be.

x-Q. 81. Under this assumption as to Young's meaning, your view would be that Young proposed to remove the thin cylindrical duplicate from the mold by collapsing it before it had cooled sufficiently to permit its removal without collapsing?

A. It appears to me that Young, in order to avoid a loss of time incident to waiting for the material to cool entirely, partially collapsed it after it had had its temperature somewhat reduced.

Defendant rests.

SHELTON T. CAMERON.

Certificate of Examiner waived.

REEVE LEWIS,

Special Examiner.

(L. S.)

Notary Public,
District of Columbia.

No. 683,615. Patented Oct. 1, 1901.

W. H. MILLER & J. W. AYLSWORTH.

METHOD OF DUPLICATING PHONOGRAPHIC RECORDS.

(Application filed July 31, 1900.)

(No Model.)

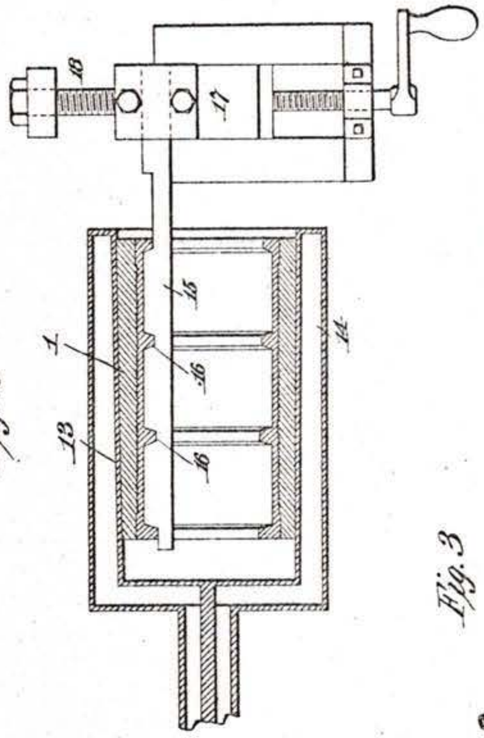
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Fig. 2

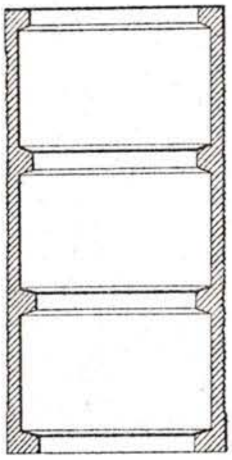

Fig. 4

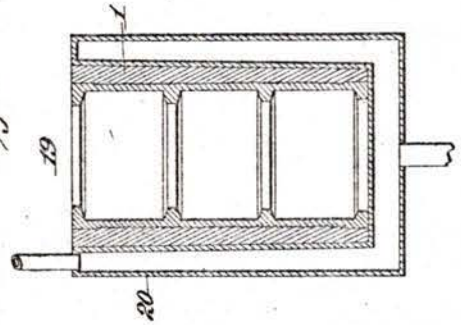

Fig. 3

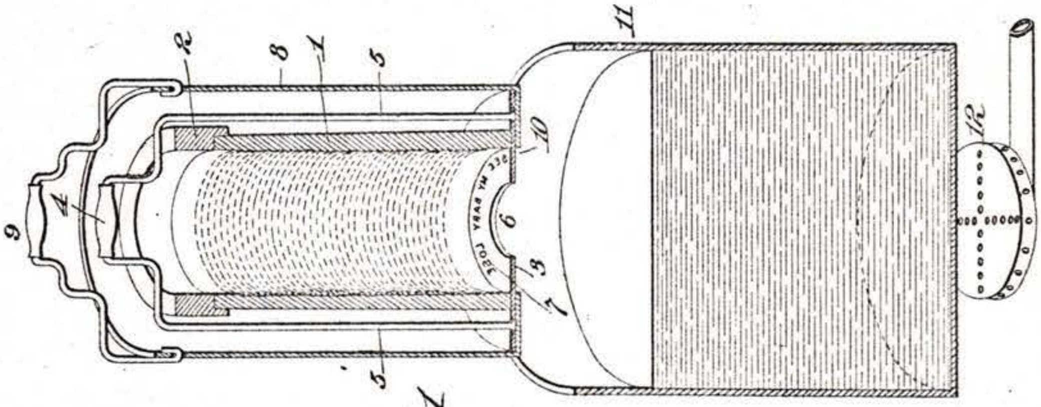
11
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Fig. 1

Witnesses:

Jas. F. Coleman

Jno. R. Taylor

Inventors

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by Dyer Edmonds & Dyer Att'ys.

THE NORRIS PETERS CO., WASHINGTON, D. C.

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UNITED STATES PATENT OFFICE.

WALTER HENRY MILLER, OF ORANGE, AND JONAS WALTER AYLSWORTH, OF EAST ORANGE, NEW JERSEY, ASSIGNORS TO NATIONAL PHONOGRAPH COMPANY OF ORANGE, NEW JERSEY.

METHOD OF DUPLICATING PHONOGRAPHIC RECORDS.

SPECIFICATION forming part of Letters Patent No. 683,615, dated October 1, 1901.

Application filed July 31, 1900. Serial No. 25,391. (No specimens.)

To all whom it may concern:

Be it known that we, WALTER HENRY MILLER, of Orange, and JONAS WALTER AYLSWORTH, of East Orange, in the county of Essex and State of New Jersey, citizens of the United States, have invented a certain new and useful Method of Duplicating Phonographic Records, of which the following is a description.

Our invention relates to an improved process of duplicating phonographic records; and our object is to provide a process by which the duplicating of phonographic records can be carried on expeditiously and economically and duplicate records produced which are of superior quality.

In carrying our invention into effect we first secure a matrix or mold from which copies are to be produced, said matrix or mold being made by any suitable and approved process—as, for instance, by a process of electroplating on a vacuous deposit preliminarily secured upon an original phonographic cylinder, the electroplating being suitably backed up and strengthened by a metal jacket and the original cylinder being removed from the electroplated coating in any suitable way, as by melting the record or by contracting it by cold. The resulting matrix will obviously be a cylinder carrying on its bore a representation in negative or relief of the original record. From the matrix or mold secured in this or in any other approved way we make duplicates by a process of immersion or dipping of the matrix or mold in a bath of molten wax-like material from which the duplicates are to be secured, whereby a coating or covering of such material will be deposited upon the interior of the matrix or mold by reason of the lower temperature of the matrix or mold. After thus securing a sufficiently thick coating of material on the interior of the matrix or mold we remove the latter from the bath, carrying the deposited material with it, and we properly finish the duplicate so secured by reaming its interior to gage, trimming one of its ends, and afterward shrinking the duplicate from the matrix or mold.

In carrying out our improved process we may utilize any suitable apparatus for the purpose, and the apparatus illustrated in the accompanying drawings, which form a part of this specification, is merely an illustrative one and we do not wish to be limited thereto.

In the drawings, Figure 1 is a sectional view of the apparatus and mold in which the deposit or coating of the wax-like material is secured; Fig. 2, a corresponding view of the apparatus for properly reaming the interior of the duplicates; Fig. 3, a similar view of the apparatus employed for the shrinking of the duplicates from the matrix or mold, and Fig. 4 an enlarged corresponding view of one of the resulting duplicates.

In all of the above views corresponding parts are represented by the same numerals of reference.

1 represents a matrix or mold carrying on its bore the representation of the record which is to be duplicated, said representation being obviously in negative or relief. This matrix or mold is made by any approved process and is not a part of our invention.

2 is a metal cap which is removably fitted upon the upper end of the matrix or mold, with its bore corresponding in diameter with the bore of the matrix or mold.

3 is a metal disk provided with a handle 4, connected to side bars 5 5 and by which the disk may be manipulated. The matrix or mold 1 is carried by the disk 3, as shown. An opening 6 in the disk 3 is of considerably less diameter than the bore of the matrix or mold, and around said opening 6 and within the bore of the matrix or mold the disk may be formed in negative with a representation 7 of suitable words or characters to indicate the subject-matter of the duplicated record, its source of origin, &c.

8 is a sheet-metal receptacle provided with a handle 9 and which carries the disk 3 and the matrix or mold 1, as shown. The receptacle 8 is provided with an opening 10 therein, which may be of the same or of larger size than the opening 6 in the disk 3.

11 represents a tank which contains, as indicated, a proper supply of suitable wax-like material from which the duplicates are to be made and which material may be the

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ordinary commercial phonographic compositions now in use. The material in the tank 11 may be kept in a molten condition by heat applied in any suitable way, as by means of a gas-burner 12.

In carrrying out our process with the apparatus so far described we place the matrix or mold on the disk 3 and insert the latter, carrying the matrix or mold in the receptacle 8, as shown, after which the receptacle 8 is immersed in the molten material within the tank 11, which is permitted to enter the matrix or mold to a point above the upper end of the latter, but below the top of the cap 2, so that the material fills the interior of the matrix or mold, but does not overflow the same. The matrix or mold is thus kept immersed in the molten material for the desired time required to secure a deposit of the wax-like material of the required thickness. With the ordinary commercial phonographic composition now used maintained at from 20° to 40° above its melting-point and with a matrix or mold having a thickness of about one-fourth of an inch a deposit of material will be formed on the interior of the matrix or mold of the desired thickness after an immersion of about three minutes. Obviously, however, this time will vary with the peculiar conditions under which the process may be carried out; but in no instance should the matrix or mold be immersed within the molten material for a long enough time to allow its temperature to be raised sufficiently to permit the deposited molten material thereon to become remelted. The reduced temperature of the matrix or mold relative to the temperature of the molten material causes the latter to become coagulated or chilled on the interior of the matrix and to deposit thereon to the thickness desired. This chilling also makes the outer surface of the resulting duplicates much smoother than is the case with duplicates made by a mechanical duplicating process. Owing to the thinness of the walls of the receptacle 8 the metal thereof very quickly attains the temperature of the molten material, so that none of the molten material will accumulate thereon. It will be understood that the matrix or mold may be made of increased thickness or be artificially cooled before the dipping operation when the composition is of a character requiring an increased cooling effect to secure the desired thickness of deposit. When the desired deposit of molten material is secured, the receptacle 8 is removed from the bath of molten material and the disk 3, carrying the mold, is removed from said receptacle. Obviously the lower edge of the resulting duplicate will be perfectly true, being formed by the portion of the disk 3 between the opening 6 and the bore of the matrix or mold, and if a representation 7 is formed on that portion of the disk such representation will be cast in the bottom end of the duplicate. The cap 2 is now removed from the matrix or mold and the upper end of the duplicate is trimmed off flush with the upper surface of the matrix or mold by any desired form of cutting-tool. The matrix or mold, which has a slightly-tapered outer surface, is now placed in a tapered chuck 13, as shown in Fig. 2, which chuck is provided with a water-jacket 14, through which cold water may circulate in order that the matrix or mold may be kept cold enough to maintain the resulting duplicate or at least the outer surface thereof in a chilled and hardened condition. The chuck 13 being rotated in any suitable way, a reaming-tool 15, held at an angle to give the desired taper to the bore of the duplicate, is introduced within the same, and by reason of the cut-away portions 16 in said reaming-tool a series of ribs will be formed on the duplicate, as shown in Fig. 4, by which the latter will be properly held upon the mandrel of the reproducing-phonograph in the usual way. The reaming-tool 15 is carried by the usual slide-head 17 of the lathe, and the depth of cut of said tool is limited by a regulating-screw 18, as shown. This reaming of the interior of the duplicate is preferably carried on before the resulting duplicate has cooled sufficiently to become hard and before it has contracted from the bore of the matrix, whereby the reaming operation can be carried on effectively and smoothly. After the interior of the duplicate has been properly reamed, as explained, the matrix or mold is removed from the chuck 13 and inserted in a cooling-mold 19, having a water-jacket 20 and through which cold water may circulate, the matrix or mold being kept in the cooling-mold until the resulting duplicate has contracted sufficiently to enable it to be removed from the matrix or mold, whereupon the operation will be completed. By reaming the interior of the resulting duplicates, as explained, to form a series of ribs therein the duplicates may be made much thinner than the ordinary original records, and hence more economically, it being of course understood that the material removed by the reaming-tool will be used for the manufacture of subsequent duplicates.

While our improved process is particularly adapted for the manufacture of duplicate records, it will be understood that the process may be carried out in connection with the manufacture of phonograph-blanks by employing a matrix or mold having a smooth bore, in which a deposit may accumulate by a process of immersion, as described. The deposited blank will be reamed on its interior, trimmed on its outer edge, and removed by shrinking or otherwise in exactly the same way as that described in connection with the manufacture of duplicate records. Such a process not only provides for the cheap and effective manufacture of phonograph-blanks, but by its carrying out a superior article is produced, since the record-surface of the blanks will be smooth and calendered in appearance. With such blanks therefore after having received a record in any suitable way the reproduction will be smoother and freer of extraneous sounds than reproductions obtained from records made on other blanks.

We do not claim herein the apparatus above described for carrying our invention into effect, since such apparatus is made the subject of our companion application filed on even date herewith and numbered serially 25,392.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is as follows:

1. The method of making a cylindrical phonographic surface, which consists in immersing a continuous tubular mold in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the mold and will chill thereon in a layer of the desired thickness, then in contracting the deposited material, and finally in removing it longitudinally from the mold, substantially as set forth.

2. The method of duplicating phonographic records, which consists in immersing a continuous cylindrical mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, then in contracting the deposited material, and finally in removing it by a direct longitudinal movement from the matrix or mold, substantially as set forth.

3. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured, and in separating the duplicate from the matrix or mold, substantially as set forth.

4. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured, and in shrinking the duplicate from the matrix or mold, substantially as set forth.

5. The method of duplicating phonographic records, which consists in immersing a mold or matrix carrying the record in relief on its bore in a molten wax-like coagulable material, whereby the material will accumulate on the bore of the matrix or mold and chill thereon in a layer of the desired thickness, in finishing the bore of the duplicate so secured before the latter has become hard, and in separating the duplicate from the matrix or mold, substantially as set forth.

6. The method of duplicating phonographic records, which consists in immersing a matrix or mold carrying the record in relief on its bore in a molten wax-like coagulable material which is excluded from the exterior of the matrix or mold and only enters the bore thereof, whereby the reduced temperature of the matrix or mold causes the material to chill on the bore and accumulate in a layer of the desired thickness, in removing the matrix or mold from the molten material, in trimming the bore of the duplicate so secured, and in separating the duplicate from the matrix or mold, substantially as set forth.

7. The method of duplicating phonographic records, which consists in immersing a matrix or mold carrying the record in relief on its bore in a molten wax-like coagulable material which is excluded from the exterior of the matrix or mold and only enters the bore thereof, whereby the reduced temperature of the matrix or mold causes the material to chill on the bore and accumulate in a layer of the desired thickness, in removing the matrix or mold from the molten material, then in maintaining the reduced temperature of the matrix or mold while the interior of the duplicate is finished, and finally in further reducing the temperature of the matrix or mold to cause the resulting duplicate to be contracted, whereby it may be removed by a direct longitudinal movement, substantially as set forth.

This specification signed and witnessed this 17th day of July, 1900.

WALTER HENRY MILLER.
JONAS WALTER AYLSWORTH.

Witnesses:
J. L. EVANS,
HENRY WACHENFELD.

No. 683,676. Patented Oct. 1, 1901.

J. W. AYLSWORTH & W. H. MILLER.

APPARATUS FOR DUPLICATING PHONOGRAPHIC RECORDS.

(Application filed July 31, 1900.)

(No Model.)

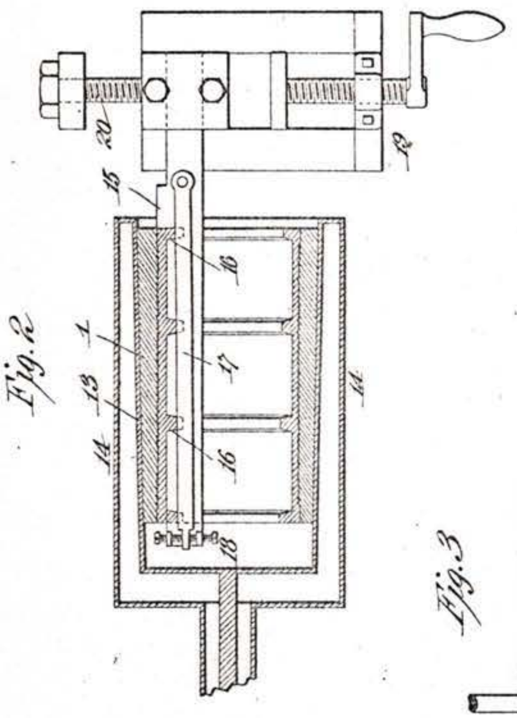
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Fig. 2

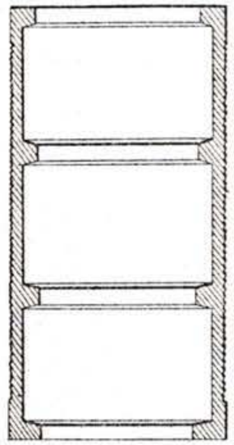

Fig. 4

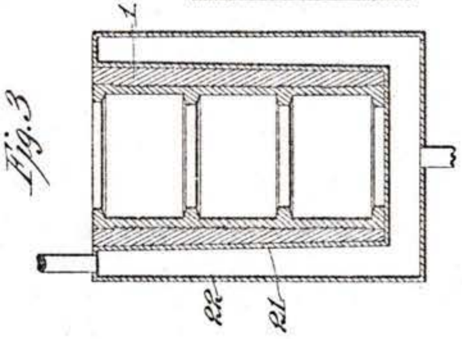

Fig. 3

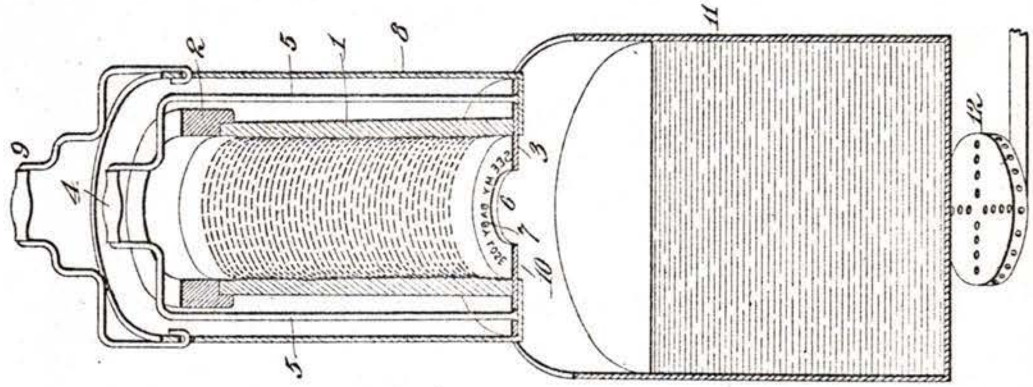
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Fig. 1

Witnesses:

Jas. F. Coleman

Jno. R. Taylor

Inventors:

Jonas Walter Aylsworth

Walter Henry Miller

by Dyer Edmonds & Dyer

Att'ys.

THE NORRIS PETERS CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JONAS WALTER AYLSWORTH, OF EAST ORANGE, AND WALTER HENRY MILLER, OF ORANGE, NEW JERSEY, ASSIGNORS TO NATIONAL PHONOGRAPH COMPANY, OF ORANGE, NEW JERSEY.

APPARATUS FOR DUPLICATING PHONOGRAPHIC RECORDS.

SPECIFICATION forming part of Letters Patent No. 683,676, dated October 1, 1901.

Application filed July 31, 1900. Serial No. 25,392. (No model.)

To all whom it may concern:

Be it known that we, JONAS WALTER AYLSWORTH, residing at East Orange, and WALTER HENRY MILLER, residing at Orange, in the county of Essex and State of New Jersey, citizens of the United States, have invented a certain new and useful Apparatus for Duplicating Phonographic Records, of which the following is a specification.

Our invention relates to an improved apparatus for duplicating phonographic records. In an application for Letters Patent filed on even date herewith, and numbered serially 25,391, we describe an improved process or method for duplicating phonographic records, which consists in immersing in a bath of molten wax-like coagulable material a matrix or mold which carries on its bore the representation in negative or relief of the record to be duplicated, whereby the molten material will fill the bore of the matrix or mold, but will be excluded from its exterior, the reduced temperature of the matrix or mold relative to the molten material causing the latter to coagulate or chill upon the bore of the matrix until a layer of the desired thickness has been secured, after which the matrix or mold is removed from the bath of molten material and the bore of the duplicate finished by a reaming-tool, the resulting duplicate being finally removed from the matrix or mold by shrinking.

The object of our present invention is to provide an improved apparatus by which the process in question may be expeditiously carried out.

In order that our invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a sectional view of the apparatus and mold in which the deposit or coating of the wax-like material is secured; Fig. 2, a corresponding view of the apparatus for properly reaming the interior of the duplicates; Fig. 3, a similar view of the apparatus employed for the shrinking of the duplicates from the matrix or mold, and Fig. 4 an enlarged corresponding view of one of the resulting duplicates.

In all of the above views corresponding parts are represented by the same numerals of reference.

1 represents a matrix or mold carrying on its bore the representation of the record which is to be duplicated, said representation being obviously in negative or relief. This matrix or mold is made by any approved process and is not a part of our invention.

2 is a metal cap, which is removably fitted upon the upper end of the matrix or mold, with its bore corresponding in diameter with the bore of the matrix or mold.

3 is a metal disk provided with a handle 4, connected to side bars 5 5 and by which the disk may be manipulated. The matrix or mold 1 is carried by the disk 3, as shown. An opening 6 in the disk 3 is of considerably less diameter than the bore of the matrix or mold, and around said opening 6 and within the bore of the matrix or mold the disk may be formed in negative with a representation 7 of suitable words or characters to indicate the subject-matter of the duplicated record, its source of origin, &c.

8 is a sheet-metal receptacle provided with a handle 9 and which carries the disk 3 and the matrix or mold 1, as shown. The receptacle 8 is provided with an opening 10 therein, which may be of the same or of larger size than the opening 6 in the disk 3.

11 represents a tank, which contains, as indicated, a proper supply of suitable wax-like material from which the duplicates are to be made, and which material may be the ordinary commercial phonographic compositions now in use. The material in the tank 11 may be kept in a molten condition by heat applied in any suitable way, as by means of a gas-burner 12.

In carrying out our process with the apparatus so far described we place the matrix or mold on the disk 3 and insert the latter, carrying the matrix or mold in the receptacle 8, as shown, after which the receptacle 8 is immersed in the molten material within the tank 11, which is permitted to enter the matrix or mold to a point above the upper end of the latter, but below the top of the cap 2, so that the material fills the interior of the matrix or mold, but does

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not overflow the same. The matrix or mold is thus kept immersed in the molten material for the desired time required to secure a deposit of the wax-like material of the required thickness. The reduced temperature of the matrix or mold relative to the temperature of the molten material causes the latter to become coagulated or chilled on the interior of the matrix and to deposit thereon to the thickness desired. This chilling also makes the outer surface of the resulting duplicates much smoother than is the case with duplicates made by a mechanical duplicating process. Owing to the thinness of the walls of the receptacle 8, the metal thereof very quickly attains the temperature of the molten material, so that none of the molten material will accumulate thereon. When the desired deposit of molten material is secured, the receptacle 8 is removed from the bath of molten material and the disk 3, carrying the mold, is removed from said receptacle. Obviously the lower edge of the resulting duplicate will be perfectly true, being formed by the portion of the disk 3 between the opening 6 and the bore of the matrix or mold, and if a representation 7 is formed on that portion of the disk such representation will be cast in the bottom end of the duplicate. The cap 2 is now removed from the matrix or mold and the upper end of the duplicate is trimmed off flush with the upper surface of the matrix or mold by any desired form of cutting-tool. The matrix or mold, which has a slightly-tapered outer surface, is now placed in a tapered chuck 13, as shown in Fig. 2, which chuck is provided with a water-jacket 14, through which cold water may circulate in order that the matrix or mold may be kept cold enough to maintain the resulting duplicate, or at least the outer surface thereof, in a chilled and hardened condition. The chuck 13 being rotated in any suitable way, a reaming-tool 15 is introduced within the same, and by reason of the cut-away portions 16 in said reaming-tool a series of ribs will be formed on the duplicate, as shown in Fig. 4, by which the latter will be properly held upon the mandrel of the reproducing-phonograph in the usual way. The reaming-tool 15 carries on one face an auxiliary cutting-blade 17, as shown, pivoted at one end and adjustable at the other by means of adjusting-screws 18. By changing the inclination of this cutting-blade 17 the depth and taper of the ribs can be regulated with the utmost certainty, so that the record can be accurately fitted to the tapered mandrel of the reproducing instrument. In other words, the ribs which are formed by the cut-away portion 16 of the reaming-tool will by the auxiliary blade 17 be cut to gradually-increasing diameters from one end of the duplicate to the other, so that the duplicate will be frictionally received upon the usual tapered mandrel. The reaming-tool 15 is carried by the usual slide-head 19 of the lathe, and the depth of cut of said tool is limited by a regulating-screw 20, as shown. After the interior of the duplicate has been properly reamed, as explained, the matrix or mold is removed from the chuck 13 and inserted in a cooling-mold 21, having a water-jacket 22, and through which cold water may circulate, the matrix or mold being kept in the cooling-mold until the resulting duplicate has contracted sufficiently to enable it to be removed from the matrix or mold, whereupon the operation will be completed. By reaming the interior of the resulting duplicates, as explained, to form a series of ribs therein the duplicates may be made much thinner than the ordinary original records, and hence more economically, it being of course understood that the material removed by the reaming-tool will be used for the manufacture of subsequent duplicates.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is as follows:

1. An improved apparatus for duplicating phonographic records, comprising a receptacle carrying a matrix or mold, the latter having the record in relief on its bore, and an opening in said receptacle concentric with the bore of the matrix or mold, whereby the receptacle with the matrix or mold may be immersed in a bath of molten, wax-like material to fill the bore of the matrix or mold but to be excluded from its exterior, substantially as set forth.

2. An improved apparatus for duplicating phonographic records, comprising a receptacle having an opening in its bottom, a disk carried by the receptacle and having a corresponding opening, and a matrix or mold seated upon said disk with its bore concentric with the opening therein, whereby the receptacle with the matrix or mold may be immersed in a bath of molten, wax-like material to fill the bore of the matrix or mold but to be excluded from its exterior, substantially as set forth.

3. An improved apparatus for duplicating phonographic records, comprising a receptacle having an opening in its bottom, a disk carried by the receptacle and having a corresponding opening, and a matrix or mold seated upon said disk with its bore concentric with the opening therein, whereby the receptacle with the matrix or mold may be immersed in a bath of molten, wax-like material to fill the bore of the matrix or mold but to be excluded from its exterior, the disk being provided between the opening therein and the bore of the matrix or mold with a representation to be molded upon the end of the desired duplicates, substantially as set forth.

4. An improved apparatus for duplicating phonographic records, comprising a receptacle having an opening in its bottom, a matrix or mold seated over said opening and carrying on its bore the representation in relief of the record to be duplicated, and a re-

movable cap carried by the upper end of the matrix or mold, whereby by immersing the receptacle in a bath of molten material the latter may enter the bore of the matrix or mold above the upper end thereof without overflowing to contact with its exterior, substantially as set forth.

5. An improved apparatus for making duplicate phonographic records, comprising a matrix or mold carrying on its bore the representation of the record to be duplicated, a disk upon which said matrix or mold is seated, said disk carrying concentrically within the bore of the matrix or mold a designation of such record, and means for depositing molten material within the matrix or mold and upon said disk, whereby the duplicate record will be formed and its designation be simultaneously cast or impressed upon the end thereof, substantially as and for the purposes set forth.

6. An improved apparatus for duplicating phonographic records, comprising the combination with means for securing a deposit of a wax-like coagulable material upon the bore of a matrix or mold which carries the representation of the record to be duplicated, of means for finishing the interior of the duplicate while the latter is in position within the matrix or mold, substantially as set forth.

7. An improved apparatus for duplicating phonographic records, comprising the combination with means for securing a deposit of a wax-like coagulable material upon the bore of a matrix or mold which carries the representation of the record to be duplicated, of means for forming within the duplicate while the latter is in position in the mold a series of concentric ribs of gradually-increasing diameters from one end of the duplicate to the other, whereby the duplicate may be properly received upon a tapered mandrel, substantially as set forth.

This specification signed and witnessed this 17th day of July, 1900.

JONAS WALTER AYLSWORTH.
WALTER HENRY MILLER.

Witnesses:
JOS. EVANS,
ELIZABETH EVANS.

No. 831,668. PATENTED SEPT. 25, 1906.

M. JOYCE.

METHOD OF DUPLICATING PHONOGRAMS.

APPLICATION FILED OCT. 13, 1897.

Fig. 1.

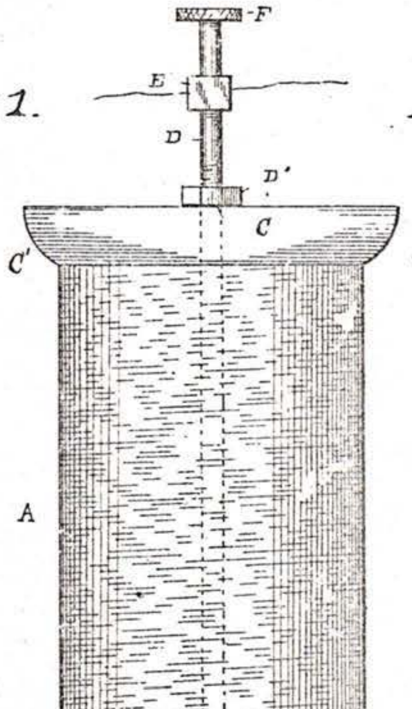


Fig. 4.

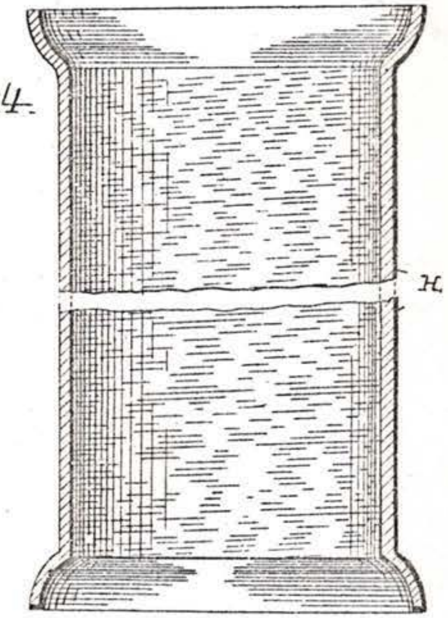


Fig. 3.

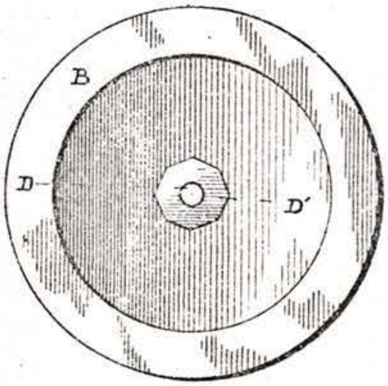


Fig. 5.

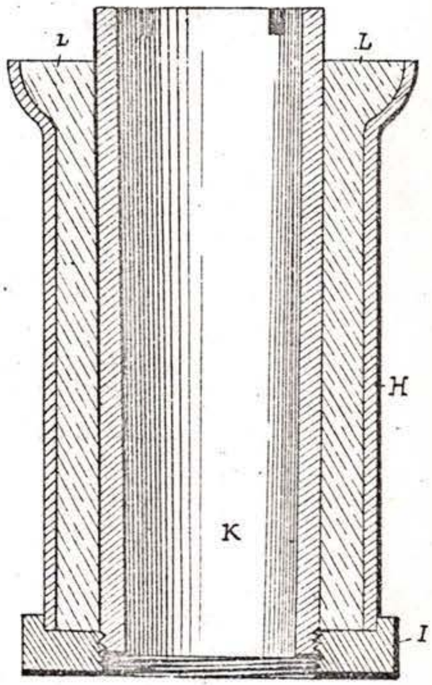
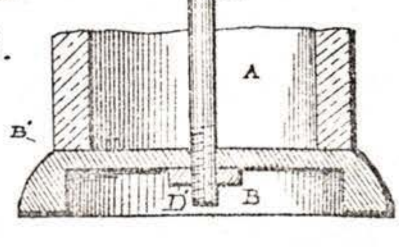


Fig. 2.



Witnesses
Chas. K. Davies.
E. A. Ryan

Inventor
M. Joyce
By W. H. Bartlett
Attorney

UNITED STATES PATENT OFFICE.

MAURICE JOYCE, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NEW JERSEY PATENT COMPANY, OF WEST ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

METHOD OF DUPLICATING PHONOGRAMS.

No. 831,668. Specification of Letters Patent. Patented Sept. 25, 1906.

Application filed October 13, 1897. Serial No. 655,027.

To all whom it may concern:

Be it known that I, MAURICE JOYCE, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Methods of Duplicating Phonograms, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to the method of duplicating or multiplying phonogram-cylinders.

The object of the invention is to reproduce facsimiles of phonogram-cylinders in as large numbers as may be desirable, and these cylinders are reproduced according to this invention in the manner hereinafter set forth.

Figure 1 is a side elevation of a phonogram with metallic end connections ready for application to an electrodeposition apparatus. Fig. 2 is a broken cross-section of a phonogram and one of the metallic end pieces and connections; Fig. 3, a face view of one metallic end piece. Fig. 4 is a broken longitudinal section of metallic mold or shell; Fig. 5, a section of mold with all parts assembled and duplicate phonogram or wax therein.

The cylinder or phonogram to be reproduced by this invention is the usual form of hollow wax cylinder, or it may be a conic frustum having the characters impressed or indented in its outer surface. I take such a cylinder and make a metallic contact with both ends. Thus A indicates the original phonogram. B is a copper or other metallic piece having a hollow base or cup and a flat disk like a cup-bottom against which the end of the phonogram is applied. The edge of this cup is made tapering, as at B′.

The cap C is somewhat similar to the base B; but as it is not necessary that this cap shall contain the retaining-nut no recess is required. The outer edge of this cap tapers at C′, and the disk-face rests against the end of the phonogram. A metallic rod D passes through both end pieces B and C, and all the parts are held firmly in contact by the nuts D′ engaging threads on this rod.

The upper end of the rod D has a metallic head E, to which the wire from an electric battery or machine is connected in usual manner, as by binding-screw F.

The parts having been assembled, as in Fig. 1, a close-fitting wax joint is made between the wax phonogram A, and the metallic ends B and C, and the surface of the phonogram and the end pieces are black-leaded. The phonogram and the metallic end pieces are then placed in a battery for electrodeposition. The end B may rest on the bottom of the battery to insure good contact. The battery fluid should come at least to the top of the cap C and preferably extend above the same. By usual means of electrodeposition copper or other metal may now be deposited, and a hollow cylinder can thus be made with its inner surface in contact with every part of the phonogram. An exact reproduction in reverse of the phonogram is thus made on the shell. This metallic shell I call a "mold." The flaring or rounded metallic end pieces B and C form, with the cylinder, a surface on which metal may be readily deposited.

The means for electrodepositing are old and well known. I assume no special novelty therein, except, perhaps, for a convenient means of holding a phonogram for use in a battery.

After the metal shell or mold has been obtained the parts are disconnected and the wax phonogram-cylinder A is melted or removed, leaving the copper or metal mold H Fig. 4, with the phonogram in reverse on its inner surface. The mold H is made with tapering or flaring ends for the purpose of affording a mouth into which melted wax can be poured. One flaring end is cut off the mold; but by having two flaring or cupped ends that one can be selected which is most desirable. After cutting off one of the ends the outside of that end of the mold is trued up in a lathe to exactly fit a base or holder I, in which a holding-cup is made, or if an exact fit be not made the mold H may be held in base I by a filling of wax or plaster, so that the mold is held firmly. A tapering core K, preferably tubular, has one end cylindrical and screw-threaded, and this screw-threaded end enters a socket in the base-piece I, so that the core is exactly central of the mold H. The mold, core, and base are slightly oiled and then heated, preferably, to near the temperature of melted wax. This heating expands mold H slightly. Then melted wax L is poured into the hot mold and fills the space between the mold H and the core K. After the wax has been poured it will generally have the exact form of the mold when cool: but under certain circumstances the wax cast may be subjected to pressure in any of the usual ways. A hydraulic, pneumatic, or other pressure may be applied to the wax column, as is done in casting metals. A good way to apply pressure, however, is to wait until the wax has partly set and then screw down the tapering core into its base I. This not only compresses, but expands the wax outwardly, insuring that all parts of the mold are impressed into and reproduced by the wax. The mold and contents may now be cooled by immersing all in a bath of cold water, or cold water may be passed through the hollow core K, or other cooling means may be employed. The cooling of the wax, which is of usual phonogram compound, causes it to shrink away from mold H, and the wax duplicate phonogram can now be removed from the end of the mold, the shrinkage being great enough to permit this removal without injury to the phonogram-record by direct longitudinal movement of the phonogram. By a repetition of the molding process multiplied copies can be obtained to any extent.

The core is preferably withdrawn from the mold with the phonogram adhering thereto. Then the core may be removed and the ends of the phonogram dressed up, so that the new phonogram is an exact reproduction of the original, or the core may be permanently left in the phonogram.

I have described a method and mechanisms for carrying the same into effect in the best manner known to me. It must be understood that I avail myself of the mechanical knowledge available in the electrotypers' and allied arts and that where equivalent steps are known I contemplate their use also.

My invention is as broad as my claim. Where I have indicated a "wax" phonogram it must be understood as applying to a phonogram of plastic material. When I refer to "black-leading," other conductive materials used as an equivalent in the electrotypers' art may be used instead of graphite. My duplicates may be made of any fusible substance used for phonograms, provided the shrinking of the material or the expansion of the metallic shell permits the withdrawal of the duplicate from the mold.

What I claim is—

1. The process of making phonograph-cylinders which consists in introducing molten material into a mold having a hollow core, and applying cold to the inner surface of the core by immersion of the mold, substantially as set forth.

2. The process of making phonograph-records which consists in introducing molten material into a mold having a hollow core, and applying cold to the outer surface of the mold and inner surface of the core, substantially as described.

3. The process of duplicating sound-records in wax-like material which consists in casting within a hot, seamless, tubular record-mold, fused wax-like material at substantially the same temperature as the mold, cooling the mold and contents so as to cause the material to shrink away from the surface of the mold, and removing the hardened casting longitudinally from the mold, substantially as set forth.

4. The process of duplicating sound-records in wax-like material which consists in casting within a hot, seamless, tubular record-mold, fused wax-like material at substantially the same temperature as the mold, allowing the material to set, cooling the mold and contents so as to cause the material to shrink away from the record-surface of the mold, and removing the hardened casting longitudinally from the mold, substantially as set forth.

5. The process of duplicating sound-records in wax-like material, which consists in casting within a hot, seamless, tubular record-mold, fused wax-like material at substantially the same temperature as the mold, allowing the material to set, applying pressure to the set material, cooling the mold and contents so as to cause the material to shrink away from the surface of the mold, and removing the hardened casting longitudinally from the mold, substantially as set forth.

6. The process of duplicating sound-records in wax-like material, which consists in casting within a hot, seamless, tubular record-mold, fused wax-like material at substantially the same temperature as the mold, placing the mold in a water-bath and removing the hardened casting longitudinally from the mold, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

MAURICE JOYCE.

Witnesses:

THOMAS J. STALEY,
W. A. BARTLETT.

No. 726,965. PATENTED MAY 5, 1903.

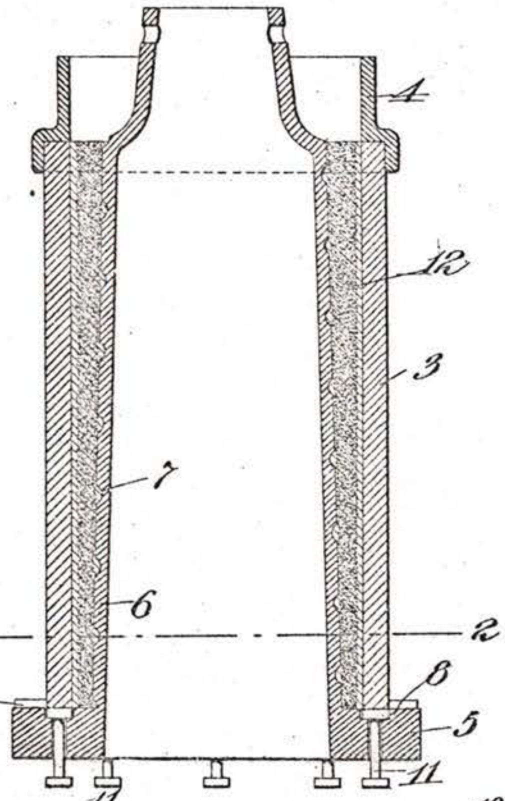
W. H. MILLER & A. N. PIERMAN.

PROCESS OF MAKING SOUND RECORDS OR BLANKS.

APPLICATION FILED NOV. 21, 1902.

NO MODEL.

Fig. 1


4
12
3
7
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2
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5
11
11

Fig. 2

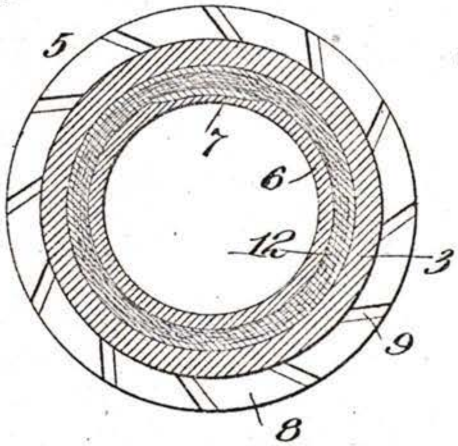
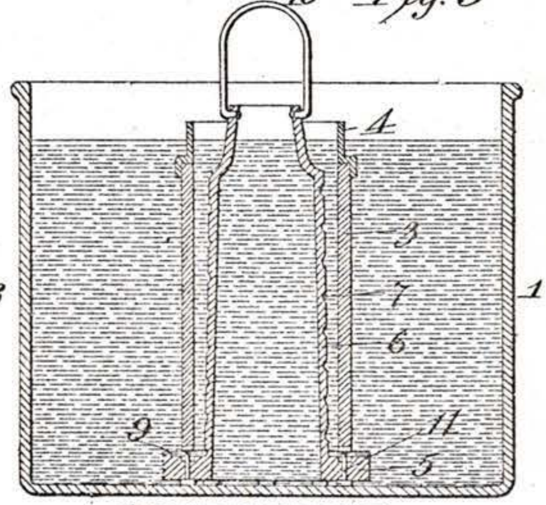


Fig. 3


10
4
3
7
1
6
9
11
5
21

Witnesses:

Jas. F. Coleman

Jno. Robt Taylor

Inventors

Walter H. Miller

Alexander N. Pierman

by Dyer Edmonds & Dyer

Attorneys

No. 726,965. Patented May 5, 1903.

UNITED STATES PATENT OFFICE.

WALTER H. MILLER, OF ORANGE, AND ALEXANDER N. PIERMAN, OF NEWARK, NEW JERSEY, ASSIGNORS TO NATIONAL PHONOGRAPH COMPANY, OF ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

PROCESS OF MAKING SOUND RECORDS OR BLANKS.

SPECIFICATION forming part of Letters Patent No. 726,965, dated May 5, 1903.

Application filed November 21, 1902. Serial No. 132,218. (No specimens.)

To all whom it may concern:

Be it known that we, WALTER H. MILLER, residing at Orange, and ALEXANDER N. PIERMAN, residing at Newark, in the county of Essex and State of New Jersey, citizens of the United States, have invented a certain new and useful Improved Process of Making Sound Records or Blanks, of which the following is a description.

Our invention relates to an improved process for making sound records and blanks, and especially for making cylindrical sound records and blanks having tapered bores.

Although our invention has been designed particularly for making our improved relatively indestructible composite records and blanks described by us in our application for Letters Patent filed on even date herewith, yet there are features of the present process which can be effectively utilized in the manufacture of records and blanks formed wholly of wax or wax-like material.

The object of our present invention, generally speaking, is to provide a process by which molded records or blanks can be expeditiously produced at low cost and of high character.

The invention resides, in the first place, in the process for molding composite records, consisting in first placing within a mold a layer of fibrous material and then flowing into the mold a wax or wax-like material which impregnates the fibrous material. When the record or blank is cylindrical in form, the process also preferably utilizes a tapered core, around which the fibrous material is first lightly wound before its introduction into the mold.

The invention consists, in the second place, of forming molded cylindrical blanks or records, either composite or not, by arranging a tapered core within a mold and introducing a molten wax or wax-like material into the space between the core and mold from the bottom upwardly, so as to expel air and prevent the formation of air-bubbles in the resulting article of manufacture.

The invention consists, in the third place, of molding a cylindrical wax or wax-like record or blank, either composite or not, with an integral molded spiral rib on its interior by flowing a molten wax or wax-like material around a hollow core and within a suitable mold.

The invention further relates to details of procedure connected with the carrying of the process into effect, such as the steps for removing the core from the molded article and for removing the latter from the mold, all as will be hereinafter more fully described and claimed.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a vertical sectional view of a cylindrical mold and tapered core, illustrating a composite cylindrical record formed therein, the parts being in position for the removal of the core; Fig. 2, a sectional view on the line 2 2 of Fig. 1, and Fig. 3 a sectional view showing a dipping-tank containing a wax or wax-like material with a cylindrical mold and tapered core introduced therein and showing the wax or wax-like material filling the space between the core and mold and also filling the hollow core.

In all of the views corresponding parts are represented by the same numerals of reference.

1 represents a tank heated in any suitable way, as by a gas-burner 2, and containing the wax or wax-like material maintained in a molten condition. The level of molten wax-like material is kept approximately constant by adding fresh material when necessary.

3 represents a hollow cylindrical mold. For the manufacture of blanks this mold is smooth on its interior; but for the manufacture of duplicates the mold is provided on its interior with a reverse or negative sound-record obtained in any well-known way.

4 represents a cap which is removably carried by the mold and which prevents material from overflowing the mold in the carrying out of the process, as will be explained.

5 represents a base which carries an integral tapered hollow core 6, formed on its ex-

terior with a spiral groove 7 in order to produce a molded spiral rib in the resulting record or blank. The base 5 is formed with a rim 8, which centers the mold and holds it concentric to the core, and said rim may be formed with grooves 9 therein to facilitate the flow of the molten material beneath the mold when the process is carried out. Engaging the upper end of the core 6 is a light bail 10, which may be removable, if desired, and by means of which the parts are introduced in and lifted from the tank 1. A number of pins 11, headed at both ends, work loosely in the base 5 and support the mold to permit a relative separation of the core and mold when the parts are introduced in the dipping-tank.

In carrying our invention into effect for the manufacture of composite records or blanks of the type described and claimed in our concurrent application we first wind a layer 12 of fibrous material lightly or loosely around the core 6 and of the desired thickness. This fibrous material is preferably ordinary cotton-batting or cotton-wool; but any other suitable fibrous material may be employed—such as cloth, absorbent paper, blotting-paper, paper-pulp, &c. The core, with its loose wrapping of fibrous material, is now inserted into the mold 3 and the cap 4 placed in position. The parts are now introduced in the dipping-tank until the pins 11 rest on the bottom of the tank or on a suitable support therein, thus permitting the core 6 and base 5 to move relatively to said pins and mold and allowing the molten material to enter the space between the core and mold from the bottom upwardly. This molten material seeps through or is absorbed by the fibrous material, driving all air before it until the level of the liquid is reached. The molten material also enters the hollow core, so that the latter is quickly brought to the temperature of the molten liquid, as is also the case with the mold itself, so that when the parts are removed from the dipping-tank there will be no appreciable congealing of the wax or wax-like material either inside of the core or outside of the mold. As soon as the space between the core and mold is completely filled, the parts are removed, the base 5 first engaging the bottom of the mold to thereby act as a valve to prevent the escape of the molten material from the space between the core and the mold. The core and mold are now dipped in cold water, which effects a rapid setting of the wax or wax-like material adjacent to the core, owing to the thinness of the walls of the latter. When the material has sufficiently set, the core is removed by unscrewing it. The blank or record may now be removed from the mold, either by allowing it to remain until it cools sufficiently to shrink away from the mold, permitting its removal, or (and preferably) the mold is inserted in a water-jacket, so as to be quickly cooled, whereby a more rapid radial contraction of the record or blank is effected. After the blank or record has been moved from the mold, its ends are finished in any suitable way, completing the manufacture.

While we have designed our improved process particularly for use in connection with the manufacture of composite records of the type invented by us, it will be understood that our process can be effectively carried out in the manufacture of records or blanks made wholly of wax or wax-like material by merely omitting the preliminary winding of a fibrous material around the core, as explained. We also wish to lay especial stress upon that feature of our process consisting in molding a blank or record around a hollow core having a spiral groove therein, because in this way we are able to successfully mold records or blanks having an integral internal spiral rib and to remove the core from the finished article without injuring the latter. If the attempt were made to cast or mold a record or blank around a solid tapered core, the considerable mass of the latter, with its relatively low radiating capacity, would prevent the successful formation of a molded spiral rib of this character.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is as follows:

1. The method of forming phonograph-tablets, that consists of molding a mass of molten record material which is normally hard and friable, throughout and around a mass of loose fibrous material, substantially as set forth.

2. The method of forming phonograph-tablets, that consists of molding a mass of molten record material which is normally hard and friable, throughout and around a loose mass of cotton-wool, substantially as set forth.

3. The process for making composite sound records or blanks which consists in introducing a layer of fibrous absorbent material in a mold, and in flowing therein a molten hard, friable wax or wax-like material to impregnate the fibrous material, substantially as and for the purposes set forth.

4. The process for making composite sound records or blanks which consists in introducing a layer of fibrous absorbent material in a cylindrical mold, and in flowing a hard, friable wax or wax-like material therein to impregnate the fibrous material, substantially as and for the purposes set forth.

5. The process for making composite sound records or blanks which consists in introducing a layer of fibrous absorbent material in a cylindrical mold and around a tapered core therein, and in introducing a molten hard, friable wax or wax-like material into the space between the core and mold to impregnate the fibrous material, substantially as and for the purposes set forth.

6. The process for making composite sound records or blanks which consists in introducing a layer of cotton-wool in a mold, and in-

troducing a molten hard, friable wax or wax-like material therein to impregnate the cotton-wool, substantially as and for the purposes set forth.

7. The process for making composite sound records or blanks which consists in introducing a layer of cotton-wool in a cylindrical mold and around a tapered core, and in introducing a molten hard, friable wax or wax-like material into the space between said mold and core to impregnate the cotton-wool, substantially as and for the purposes set forth.

8. The process for making sound records or blanks which consists in casting a record or blank around a hollow tapered core having a spiral groove therein, and in simultaneously introducing molten material within said core, substantially as and for the purposes set forth.

9. The process for making sound records or blanks which consists in casting a molten wax or wax-like material within a mold and around a hollow tapered core having a spiral groove therein, and in simultaneously introducing the molten wax or wax-like material within said core, substantially as and for the purposes set forth.

10. The process for making composite sound records or blanks which consists in first lightly wrapping a fibrous absorbent material around a tapered core, then in introducing the core and fibrous material in a cylindrical mold, and finally in introducing a molten hard, friable wax or wax-like material into the space between the core and mold to impregnate the fibrous material, substantially as and for the purposes set forth.

11. The process for making composite sound records or blanks which consists in first lightly wrapping a fibrous absorbent material around a tapered core, then in introducing the core and fibrous material in a cylindrical mold, and finally in introducing a molten hard, friable wax or wax-like material into the space between the core and mold to impregnate the fibrous material, the molten material being introduced from the bottom upwardly, substantially as and for the purposes set forth.

This specification signed and witnessed this 19th day of November, 1902, and this 31st day of October, 1902, respectively.

WALTER H. MILLER.
ALEXANDER N. PIERMAN.

Witnesses to signature of Walter H. Miller:
HARRY F. MILLER,
S. S. BROWN.

Witnesses to signature of Alexander N. Pierman:
W. J. BUEHLER,
W. PUGH.

No. 726,966. PATENTED MAY 5, 1903.

W. H. MILLER & A. N. PIERMAN.

SOUND RECORD OR BLANK.

APPLICATION FILED NOV. 21, 1902.

NO MODEL.

Fig. 1

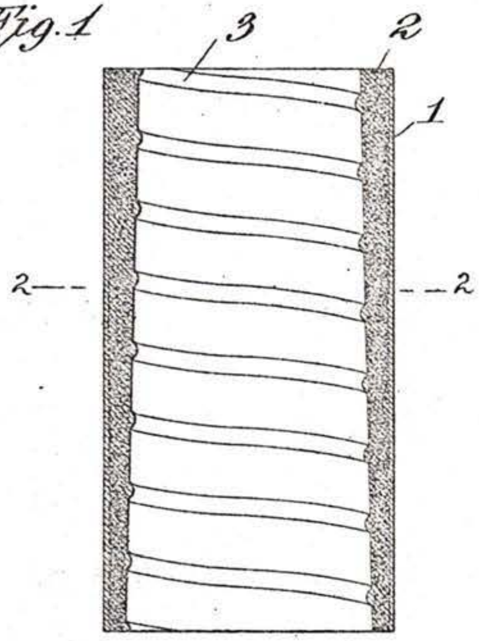


Fig. 2

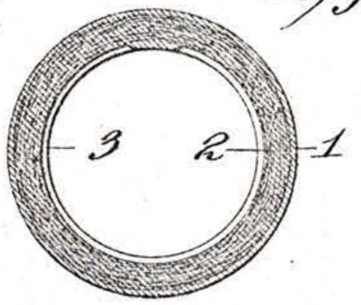
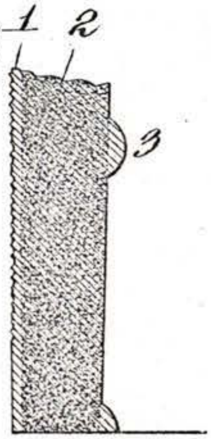


Fig. 3.



Witnesses:

Jas. F. Coleman

Jno. Robt. Taylor

Inventors

Walter H. Miller

Alexander N. Pierman

by Dyer Edmonds & Dyer

Attorneys

No. 726,966. Patented May 5, 1903.

UNITED STATES PATENT OFFICE.

WALTER H. MILLER, OF ORANGE, AND ALEXANDER N. PIERMAN, OF NEWARK, NEW JERSEY, ASSIGNORS TO NATIONAL PHONOGRAPH COMPANY, OF ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

SOUND RECORD OR BLANK.

SPECIFICATION forming part of Letters Patent No. 726,966, dated May 5, 1903.

Application filed November 21, 1902. Serial No. 132,219. (No model.)

To all whom it may concern:

Be it known that we, WALTER H. MILLER, residing at Orange, and ALEXANDER N. PIERMAN, residing at Newark, in the county of Essex and State of New Jersey, citizens of the United States, have invented a certain new and useful Improvement in Sound Records or Blanks, of which the following is a description.

Our invention relates to improvements in sound records or blanks either in the form of cylinders or flat disks; and our object is to produce a sound record or blank which while presenting a record-surface of a suitable amorphous wax-like material is at the same time sufficiently durable as to be indestructible under ordinary conditions.

Blanks and records made of the ordinary wax or wax-like materials are very fragile and delicate in character and are frequently cracked and broken in the act of placing them in position on a recording or reproducing machine, and in the case of cylindrical blanks or records they frequently become broken or cracked merely by falling from a vertical to a horizontal position, while such records or blanks if allowed to fall from a height of only a few feet on a moderately hard surface will be shattered ordinarily into many pieces, and in any event the delicate record-surface will be destroyed. Our improved record or blank is so durable that it may be dropped or even thrown upon the floor with considerable force without encountering any objectionable injury to its record-surface, and if the latter cracks at all the cracks are so microscopic that they do not affect the reproduction.

Broadly stated, our invention comprises a sound record or blank made of any suitable and ordinary wax or wax-like material and containing in its mass a sufficient bulk of fibrous material as to secure the desired durability, the fibrous material being completely penetrated and inclosed by the wax-like material. The fibrous material which we prefer to use and which we have successfully employed in practice is ordinary cotton-wool or cotton-batting; but other fibrous materials may be used, such as cloth, absorbent paper, blotting-paper, paper-pulp, &c.

In its preferred form the invention comprises a sound record or blank the recording-surface of which is formed wholly of a suitable amorphous wax or wax-like material and the main portion of which is composed of a fibrous material like cotton-wool, wholly impregnated by the wax-like material, so that the individual fibers of the fibrous material will be surrounded by the wax-like material.

When our invention is employed in connection with cylindrical records or blanks, it preferably also comprises a spiral rib molded on its interior for engaging the usual tapered core, which rib is formed wholly of the wax or wax-like material.

Finally, the invention in its most approved form comprises a duplicate sound-record made of molten wax or wax-like material impregnating a mass of fibrous material and carrying a molded sound-record groove on its record-surface, the latter being preferably amorphous and free of fibers.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a vertical sectional view through a cylindrical record or blank, showing our invention in its preferred form; Fig. 2, a section on the line 2 2 of Fig. 1, and Fig. 3 an enlarged detailed vertical section illustrating a molded sound-record embodying our invention.

In all of the views corresponding parts are represented by the same numerals of reference.

In its preferred form the invention comprises a portion 1, on which the record is formed and which is composed wholly of the usual amorphous wax or wax-like material, and a portion 2, comprising the body of the record or blank, which portion is formed of the same wax or wax-like material impregnating a suitable fibrous material, the entire mass of wax or wax-like material being substantially integral or continuous throughout. When the record or blank is of cylindrical form, it also preferably comprises a spiral rib 3, made of the same wax or wax-like material. The whole record is molded, and when the invention is utilized in connection with duplicate sound-records the record-groove may be molded contemporaneously with the formation of the record itself. Such a molded record-groove is shown in Fig. 3 by the numeral 4.

Our improved record or blank is made by any suitable process, but preferably by a special process which we have invented and which we have made the subject of an application for Letters Patent filed on even date herewith. In carrying this method into effect we first take a hollow tapered core and wind quite loosely around it a thickness of the fibrous material, preferably ordinary cotton-batting or cotton-wool. This core, with its wrapping of fibrous material, is then inserted in a cylindrical mold, which for the manufacture of blanks is smooth on its interior, while for the manufacture of duplicate sound-records it is provided on its interior with a negative record-groove. A molten wax-like material is now introduced into the space between the mold and core, preferably from the bottom upward, and intimately fills that space, impregnating the fibrous material and practically surrounding each individual fiber of the latter. After the wax-like material has been allowed to set the core is removed, after which the blank or record is removed from the mold by contracting the blank or record radially by a chilling operation.

We find in practice that blanks and records made in accordance with our invention possess all the advantages of blanks and records made wholly of wax or wax-like material so far as superiority of reproduction is concerned, since with our blank or record the record-surface is identical with the record-surfaces of blanks or records made wholly of wax or wax-like material. Our improved blank or record possesses, however, the immense superiority over blanks or records made wholly of wax or wax-like material in being so strong and durable that it may be dropped from a considerable height or be actually thrown upon the floor without breaking or cracking the record-surface, and if any cracks are formed they are so microscopic as not to affect the reproduction. We find, in fact, that with our improved blank or record the latter is actually elastic, due to the presence of the relatively large mass of fibrous material therein, and can be actually collapsed to a considerable extent without injuriously affecting the character of the record-surface.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is as follows:

1. As a new article of manufacture, a sound record or blank composed of normally hard and friable material adapted to be molded and containing within its mass fibrous material to render the same less friable, substantially as set forth.

2. As a new article of manufacture, a sound record or blank composed of normally hard and friable material adapted to be molded and containing within its mass cotton-wool to render the same less friable, substantially as set forth.

3. As a new article of manufacture, a sound record or blank made of fibrous material, and a hard, friable wax or wax-like material impregnating the fibrous material to surround the individual fibers thereof, substantially as set forth.

4. As a new article of manufacture, a sound record or blank having a record-surface of hard, friable wax or wax-like material, and a main portion formed of a fibrous material completely impregnated with wax or wax-like material, substantially as set forth.

5. As a new article of manufacture, a sound record or blank made of molten hard, friable wax or wax-like material completely impregnating a fibrous material, substantially as set forth.

6. As a new article of manufacture, a sound record or blank made of molten hard, friable wax or wax-like material completely impregnating a fibrous material, with a record-surface formed wholly of such wax or wax-like material, substantially as set forth.

7. As a new article of manufacture, a cylindrical sound record or blank formed of a cylinder of fibrous material completely impregnated with hard, friable wax or wax-like material, substantially as set forth.

8. As a new article of manufacture, a cylindrical sound record or blank formed of a cylinder of fibrous material completely impregnated with hard, friable wax or wax-like material, with a record-surface formed of such wax or wax-like material, substantially as set forth.

9. As a new article of manufacture, a cylindrical sound record or blank formed of a fibrous material completely impregnated with hard, friable wax or wax-like material, and an interior spiral rib integral with the wax or wax-like material, substantially as set forth.

10. As a new article of manufacture, a cylindrical sound record or blank formed of a fibrous material completely impregnated with hard, friable wax or wax-like material, and an interior spiral rib integral with the wax or wax-like material and formed wholly of such wax or wax-like material, substantially as set forth.

11. As a new article of manufacture, a cylindrical sound record or blank composed of fibrous material with a molten hard, friable wax or wax-like material completely impregnating the fibrous material, substantially as set forth.

12. As a new article of manufacture, a cylindrical sound record or blank composed of

fibrous material with a molten hard, friable wax or wax-like material completely impregnating the fibrous material, with a record-surface formed wholly of the wax or wax-like material, substantially as set forth.

13. As a new article of manufacture, a cylindrical sound record or blank composed of fibrous material with a molten hard, friable wax or wax-like material completely impregnating the fibrous material, with a record-surface formed wholly of the wax or wax-like material, and with an interior spiral groove formed wholly of the wax or wax-like material, substantially as set forth.

14. As a new article of manufacture, a duplicate sound-record formed of a fibrous material with a molten hard, friable wax or wax-like material completely impregnating the same, and with a molded record-groove carried by the wax-like material, substantially as set forth.

15. As a new article of manufacture, a sound record or blank composed of cotton-wool completely impregnated with hard, friable wax or wax-like material, substantially as set forth.

16. As a new article of manufacture, a sound record or blank composed of cotton-wool completely impregnated with hard, friable wax or wax-like material, with a record-surface formed wholly of the wax or wax-like material, substantially as set forth.

17. As a new article of manufacture, a cylindrical sound record or blank composed of a cylinder of cotton-wool completely impregnated with hard, friable wax or wax-like material, substantially as set forth.

18. As a new article of manufacture, a cylindrical sound record or blank composed of a cylinder of cotton-wool completely impregnated with hard, friable wax or wax-like material, and with a record-surface formed wholly of wax or wax-like material, substantially as set forth.

19. As a new article of manufacture, a cylindrical sound record or blank composed of a cylinder of cotton-wool completely impregnated with hard, friable wax or wax-like material, with a record-surface formed wholly of wax or wax-like material, and an internal spiral groove formed wholly of wax or wax-like material, substantially as set forth.

20. As a new article of manufacture, a duplicate sound-record composed of a fibrous material, a molten hard, friable wax-like material completely impregnating the same, and a molded record-groove carried by the wax or wax-like material, substantially as set forth.

21. As a new article of manufacture, a duplicate sound-record composed of cotton-wool completely impregnated with a molten hard, friable wax or wax-like material, and a molded record-groove carried by the wax or wax-like material, substantially as set forth.

22. As a new article of manufacture, a duplicate cylindrical sound-record comprising a cylinder of cotton-wool completely impregnated with a hard, friable wax or wax-like material, and a molded record-groove formed in the wax or wax-like material, substantially as set forth.

23. As a new article of manufacture, a cylindrical duplicate sound-record comprising a cylinder of cotton-wool completely impregnated with a hard, friable wax or wax-like material and having a record-surface formed wholly of wax or wax-like material, and a molded record-groove carried within said record-surface, substantially as set forth.

This specification signed and witnessed this 19th day of November, 1902.

WALTER H. MILLER.

Witnesses to signature of Walter H. Miller:
HARRY F. MILLER,
S. S. BROWN.

This specification signed and witnessed this 31st day of October, 1902.

ALEXANDER N. PIERMAN.

Witnesses to signature of Alexander N. Pierman:
W. J. BUEHLER,
W. PUGH.

T. A. EDISON.
Phonograph or Speaking Machine.

No. 200,521. Patented Feb. 19, 1878.

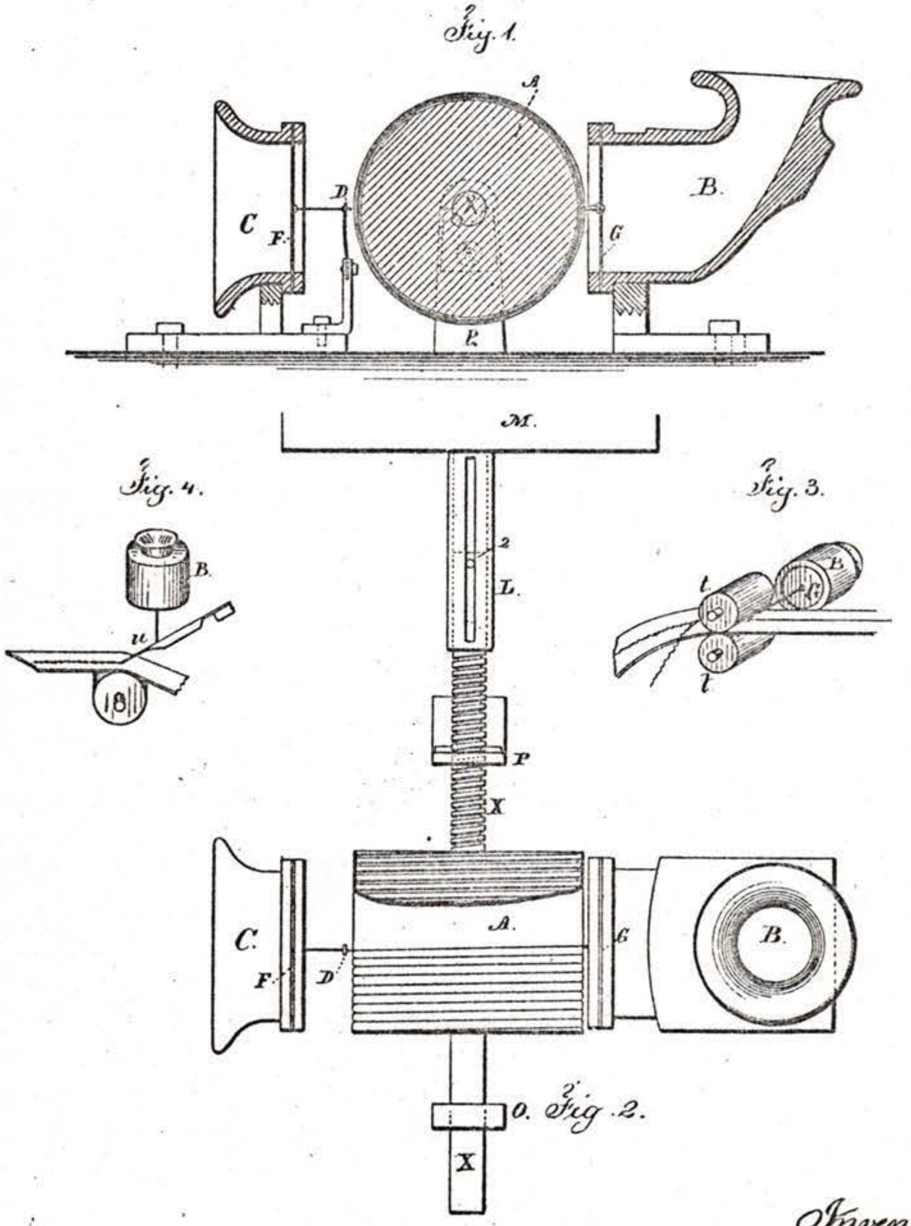


Fig. 1.
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Fig. 4.
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O.
Fig. 2.
X

Witnesses
Chas H. Smith
Harold Serrell

Inventor
Thomas A. Edison.
per Lemuel W. Serrell
atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

IMPROVEMENT IN PHONOGRAPH OR SPEAKING MACHINES.

Specification forming part of Letters Patent No. **200,521**, dated February 19, 1878; application filed December 24, 1877.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an Improvement in Phonograph or Speaking Machines, of which the following is a specification:

The object of this invention is to record in permanent characters the human voice and other sounds, from which characters such sounds may be reproduced and rendered audible again at a future time.

The invention consists in arranging a plate, diaphragm, or other flexible body capable of being vibrated by the human voice or other sounds, in conjunction with a material capable of registering the movements of such vibrating body by embossing or indenting or altering such material, in such a manner that such register-marks will be sufficient to cause a second vibrating plate or body to be set in motion by them, and thus reproduce the motions of the first vibrating body.

The invention further consists in the various combinations of mechanism to carry out my invention.

I have discovered, after a long series of experiments, that a diaphragm or other body capable of being set in motion by the human voice does not give, except in rare instances, superimposed vibrations, as has heretofore been supposed, but that each vibration is separate and distinct, and therefore it becomes possible to record and reproduce the sounds of the human voice.

In the drawings, Figure 1 is a vertical section, illustrating my invention, and Fig. 2 is a plan of the same.

A is a cylinder having a helical indenting-groove cut from end to end—say, ten grooves to the inch. Upon this is placed the material to be indented, preferably metallic foil. This drum or cylinder is secured to a shaft, X, having at one end a thread cut with ten threads to the inch, the bearing P also having a thread cut in it.

L is a tube, provided with a longitudinal slot, and it is rotated by the clock-work at M, or other source of power.

The shaft X passes into the tube L, and it is rotated by a pin, 2, secured to the shaft, and passing through the slot on the tube L, the object of the long slot being to allow the shaft X to pass endwise through the center or support P by the action of the screw on X. At the same time that the cylinder is rotated it passes toward the support O.

B is the speaking-tube or mouth-piece, which may be of any desired character, so long as proper slots or holes are provided to re-enforce the hissing consonants. Devices to effect this object are shown in my application, No. 143, filed August 23, 1877. Hence they are not shown or further described herein.

Upon the end of the tube or mouth-piece is a diaphragm, having an indenting-point of hard material secured to its center, and so arranged in relation to the cylinder A that the point will be exactly opposite the groove in the cylinder at any position the cylinder may occupy in its forward rotary movement.

The speaking-tube is arranged upon a standard, which, in practice, I provide with devices for causing the tube to approach and recede from the cylinder.

The operation of recording is as follows: The cylinder is, by the action of the screw in X, placed adjacent to the pillar P, which brings the indenting-point of the diaphragm G opposite the first groove on the cylinder, over which is placed a sheet of thick metallic foil, paper, or other yielding material. The tube B is then adjusted toward the cylinder until the indenting-point touches the material and indents it slightly. The clock-work is then set running, and words spoken in the tube B will cause the diaphragm to take up every vibration, and these movements will be recorded with surprising accuracy by indentations in the foil.

After the foil on the cylinder has received the required indentations, or passed to its full limit toward O, it is made to return to P by proper means, and the indented material is brought to a position for reproducing and rendering audible the sounds that had been made by the person speaking into the tube B.

C is a tube similar to B, except that the diaphragm is somewhat lighter and more sensitive, although this is not actually necessary. In front of this diaphragm is a light spring, D, having a small point shorter and finer than the indenting-point on the diaphragm of B. This spring and point are so arranged as to fall

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exactly into the path of all the indentations. This spring is connected to the diaphragm F of C by a thread or other substance capable of conveying the movements of D. Now, when the cylinder is allowed to rotate, the spring D is set in motion by each indentation corresponding to its depth and length. This motion is conveyed to the diaphragm either by vibrations through a thread or directly by connecting the spring to the diaphragm F, and these motions being due to the indentations, which are an exact record of every movement of the first diaphragm, the voice of the speaker is reproduced exactly and clearly, and with sufficient volume to be heard at some distance.

The indented material may be detached from the machine and preserved for any length of time, and by replacing the foil in a proper manner the original speaker's voice can be reproduced, and the same may be repeated frequently, as the foil is not changed in shape if the apparatus is properly adjusted.

The record, if it be upon tin-foil, may be stereotyped by means of the plaster-of-paris process, and from the stereotype multiple copies may be made expeditiously and cheaply by casting or by pressing tin-foil or other material upon it. This is valuable when musical compositions are required for numerous machines.

It is obvious that many forms of mechanism may be used to give motion to the material to be indented. For instance, a revolving plate may have a volute spiral cut both on its upper and lower surfaces, on the top of which the foil or indenting material is laid and secured in a proper manner. A two-part arm is used with this disk, the portion beneath the disk having a point in the lower groove, and the portion above the disk carrying the speaking and receiving diaphragmic devices, which arm is caused, by the volute spiral groove upon the lower surface, to swing gradually from near the center to the outer circumference of the plate as it is revolved, or vice versa.

An apparatus of this general character adapted to a magnet that indents the paper is shown in my application for a patent, No. 128, filed March 26, 1877; hence no claim is made herein to such apparatus, and further description of the same is unnecessary.

A wide continuous roll of material may be used, the diaphragmic devices being reciprocated by proper mechanical devices backward and forward over the roll as it passes forward; or a narrow strip like that in a Morse register may be moved in contact with the indenting-point, and from this the sounds may be reproduced. The material employed for this purpose may be soft paper saturated or coated with paraffine or similar material, with a sheet of metal foil on the surface thereof to receive the impression from the indenting-point.

I do not wish to confine myself to reproducing sound by indentations only, as the transmitting or recording device may be in a sinuous form, resulting from the use of a thread passing with paper beneath the pressure-rollers *t*, (see Fig. 3,) such thread being moved laterally by a fork or eye adjacent to the roller *t*, and receiving its motion from the diaphragm G, with which such fork or eye is connected, and thus record the movement of the diaphragm by the impression of the thread in the paper to the right and left of a straight line, from which indentation the receiving-diaphragm may receive its motion and the sound be reproduced, substantially in the manner I have already shown; or the diaphragm may, by its motion, give more or less pressure to an inking-pen, *u*, Fig. 4, the point of which rests upon paper or other material moved along regularly beneath the point of the pen, thus causing more or less ink to be deposited upon the material, according to the greater or lesser movement of the diaphragm. These ink-marks serve to give motion to a second diaphragm when the paper containing such marks is drawn along beneath the end of a lever resting upon them and connected to such diaphragm, the lever and diaphragm being moved by the friction between the point being greatest, or the thickness of the ink being greater where there is a large quantity of ink than where there is a small quantity. Thus the original sound-vibrations are reproduced upon the second diaphragm.

I claim as my invention—

1. The method herein specified of reproducing the human voice or other sounds by causing the sound-vibrations to be recorded, substantially as specified, and obtaining motion from that record, substantially as set forth, for the reproduction of the sound-vibrations.

2. The combination, with a diaphragm exposed to sound-vibrations, of a moving surface of yielding material—such as metallic foil—upon which marks are made corresponding to the sound-vibrations, and of a character adapted to use in the reproduction of the sound, substantially as set forth.

3. The combination, with a surface having marks thereon corresponding to sound-vibrations, of a point receiving motion from such marks, and a diaphragm connected to said point, and responding to the motion of the point, substantially as set forth.

4. In an instrument for making a record of sound-vibrations, the combination, with the diaphragm and point, of a cylinder having a helical groove and means for revolving the cylinder and communicating an end movement corresponding to the inclination of the helical groove, substantially as set forth.

Signed by me this 15th day of December, A. D. 1877.

THOS. A. EDISON.

Witnesses:
GEO. T. PINCKNEY,
CHAS. H. SMITH.

(No Model.) 4 Sheets—Sheet 1.

C. A. BELL & S. TAINTER.

RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig. 1.

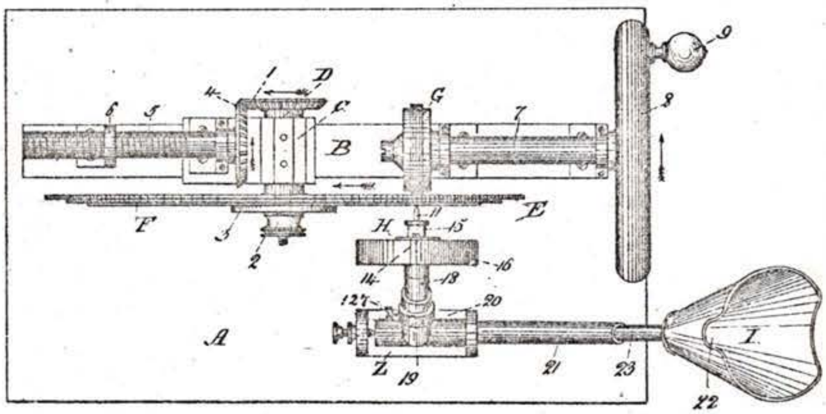
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Fig. 3.

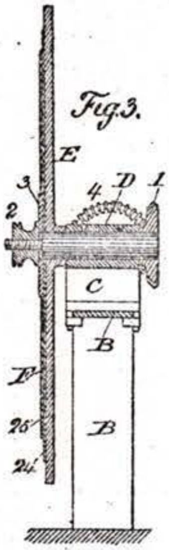
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Fig. 2.

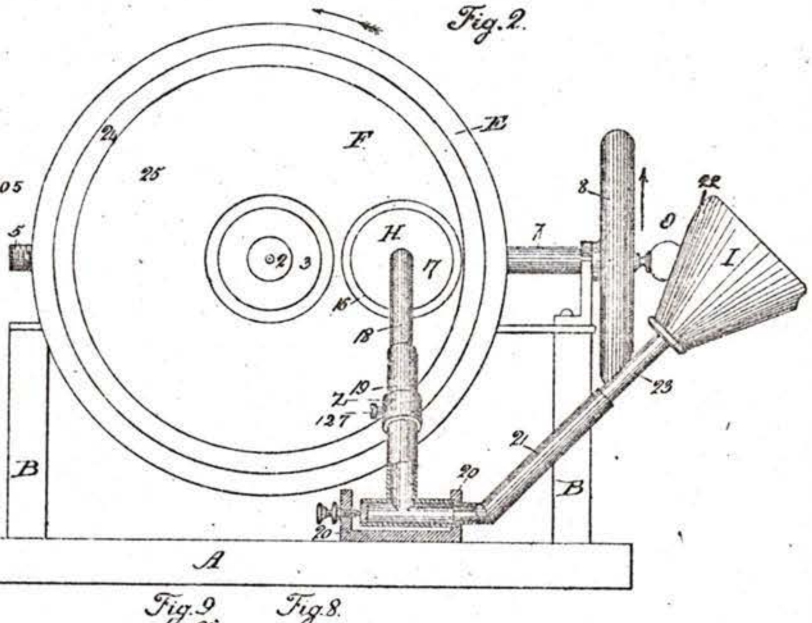
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Fig. 4.

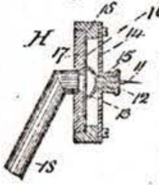
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Fig. 5.

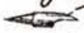

Fig. 6.

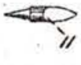

Fig. 9

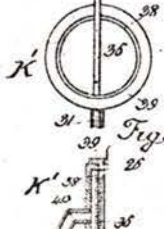
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Fig. 8.

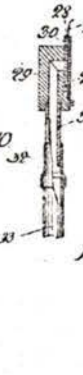
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Fig. 10

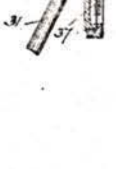
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Fig. 7

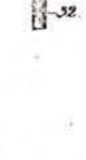
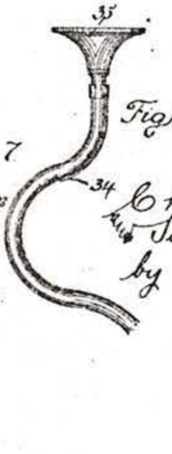


Fig. 11.



Witnesses.
Wm. Kirkus Jr.
C. J. Hedrick

Inventors.
Chichester A. Bell
Sumner Tainter
by A. Pollok
their attorney

(No Model.) 4 Sheets—Sheet 2.

C. A. BELL & S. TAINTER.

RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig. 12.

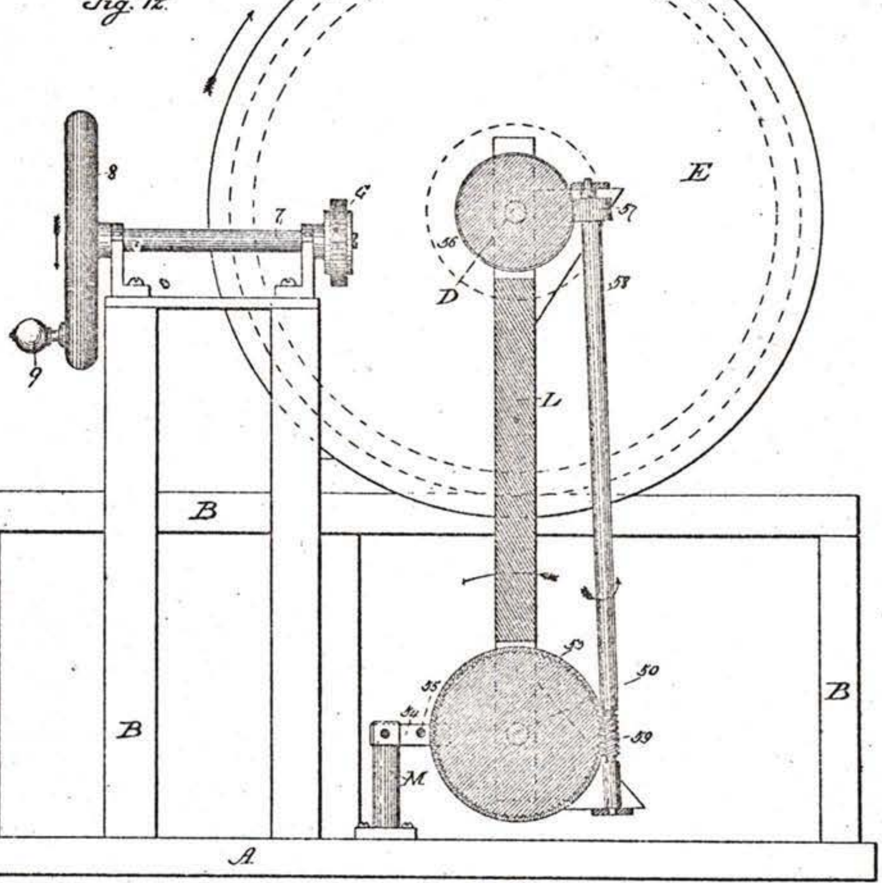

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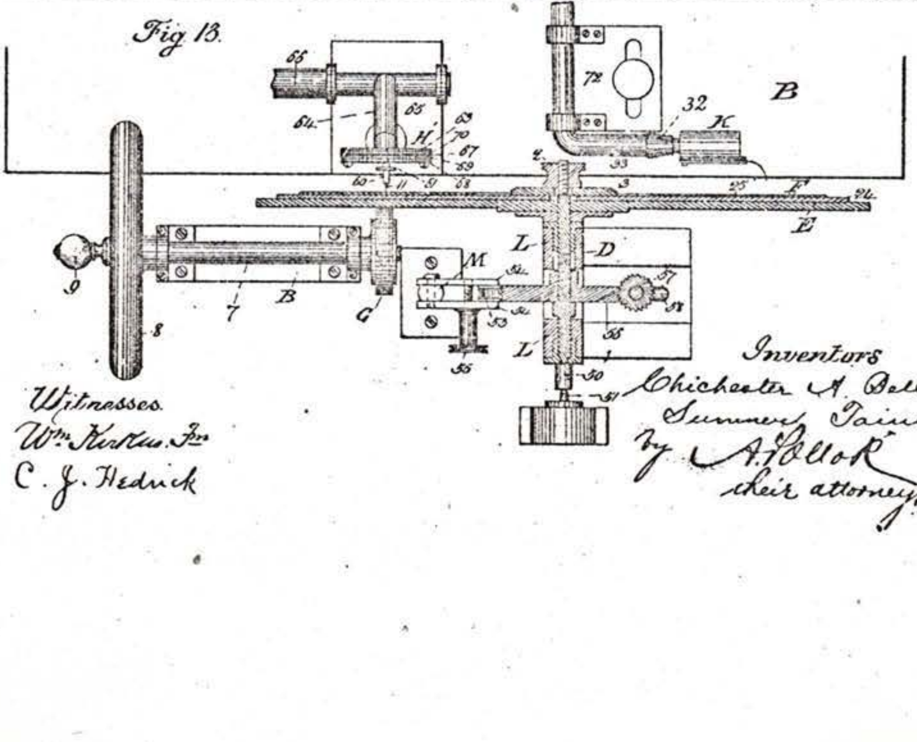
Fig 13.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E
L
D
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B
G
53
54
55
8
56
L
50
51

Witnesses.
Wm. Kirkus. Jr.
C. J. Hedrick

Inventors
Chichester A. Bell
Sumner Tainter
by A. Pollok
their attorney

(No Model.) 4 Sheets—Sheet 3.

C. A. BELL & S. TAINTER.

RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig 14.

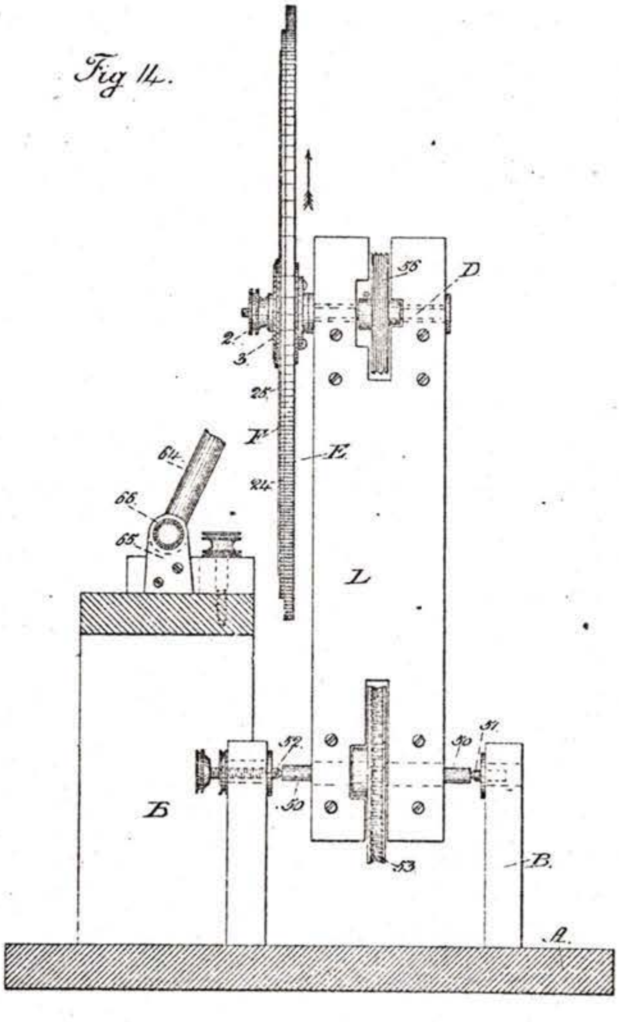
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Fig. 21.

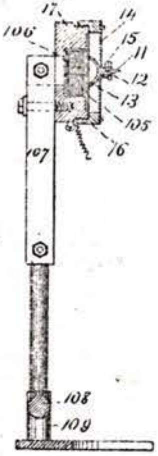
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Fig. 15.

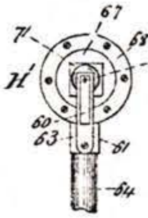
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Fig 16.

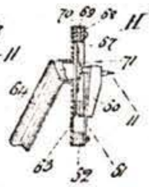
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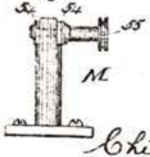
Fig 17.



Witnesses.
Wm Kirkus Jr.
C. J. Hedrick

Inventor.
Chichester A. Bell
Sumner Tainter
by A. Pollok
their attorney.

(No Model.) 4 Sheets—Sheet 4.

C. A. BELL & S. TAINTER.

RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

No. 341,214. Patented May 4, 1886.

Fig 18.

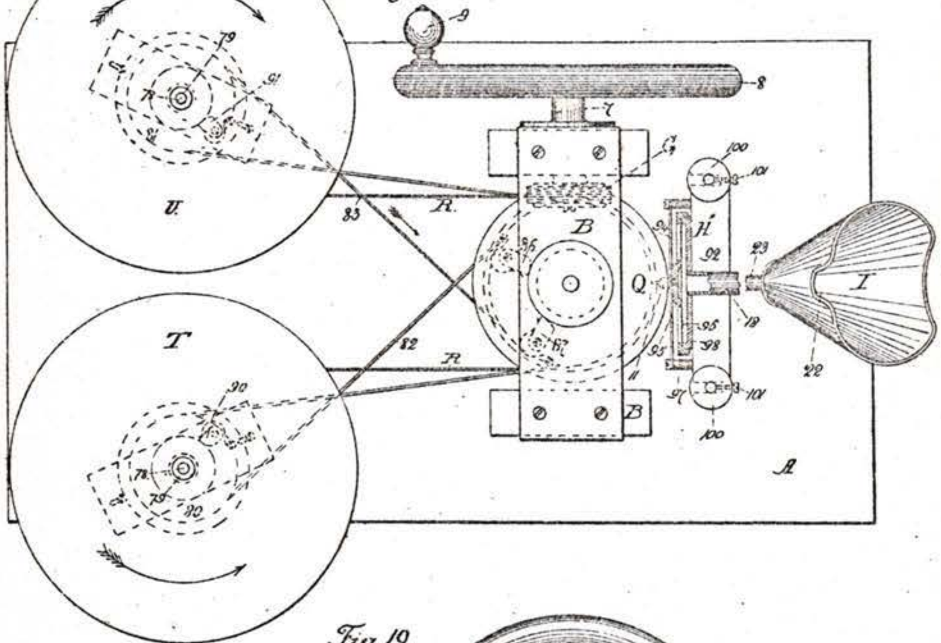


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Fig. 19.

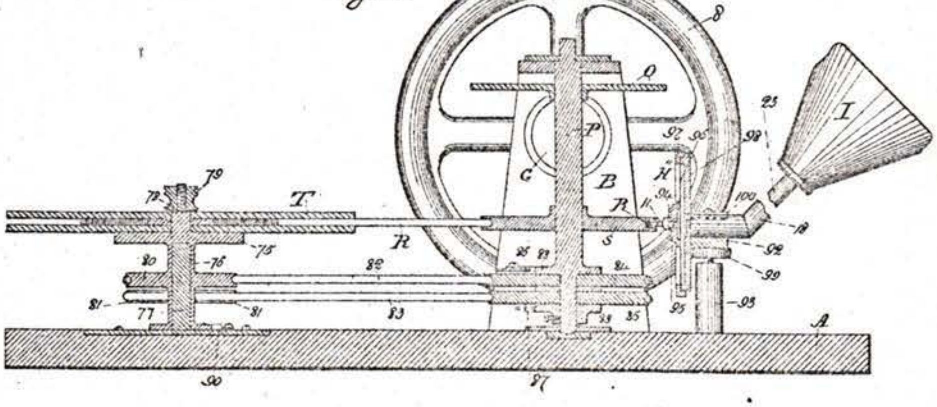

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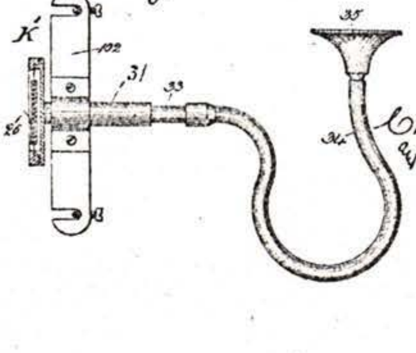
Fig 20.



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UNITED STATES PATENT OFFICE.

CHICHESTER A. BELL AND SUMNER TAINTER, OF WASHINGTON, D. C.

RECORDING AND REPRODUCING SPEECH AND OTHER SOUNDS.

SPECIFICATION forming part of Letters Patent No 341 214, dated May 4, 1886.

Application filed June 27, 1885. Serial No. 170,044. (No model.)

To all whom it may concern:

Be it known that we, CHICHESTER A. BELL and SUMNER TAINTER, both of Washington, in the District of Columbia, have invented a new and useful Improvement in Recording and Reproducing Speech and other Sounds, which improvement is fully set forth in the following specification.

This invention relates to the formation, in a solid substance, of elevations and depressions, or other inequalities corresponding more or less perfectly to the forms of sound-vibrations, and the reproduction, by means of such inequalities, of the sounds represented by them.

The invention consists, first, in the formation of the record or "phonogram," as it has been called, by means of a cutting-style which is vibrated by the sound-waves or sonorous vibrations to be recorded. The vibrations may be impressed upon the style directly by the impact of the sound-waves upon some device mechanically connected with or carried by the cutting-style or its support, or indirectly through the action of an electric current or other suitable vibratory medium. Heretofore a large number of contrivances have been devised for converting electrical impulses into mechanical vibrations, and they could, of course, be used for vibrating the cutting-style. Otherwise they have no relation to this part of the present invention, the essential new feature of which is the removal of material to form the record by a cutting, gouging, or graving action of the vibrating style. Heretofore the vibrating style has, as in Edison's well-known phonograph, simply indented the recording material. It has been proposed to cut the record in the edge of a strip of metal or other solid material by vibrating the strip in contact with the cutting-edge of a rotary disk cutter; but this proposal is essentially different from this invention, the new mode being applicable to cutting the record upon all sorts of surfaces, and not upon strips only, and is, besides, believed to be later in time than this invention. Under this part of the invention are included the vibratory cutting-style as a new device in a sound-recorder, and the combination of the same with other devices; also the cut or engraved record itself. In this new or improved form of record not only may a larger number of words or sounds be recorded in a given surface than has been practicable with the indented records heretofore in use, but the recorded vibrations are also sharper and better defined. It is found that an indenting style smooths over the crests of the larger elevations, and also rubs out some of the finer ones.

The invention consists, secondly, in engraving or cutting the record in a waxy or amorphous, and slightly cohesive substance. Preferably, a compound of beeswax and paraffine (the latter in excess) is employed. This compound has no tendency to clog the style, but is readily removed thereby in chips or shavings. This part of the invention also consists in a recording material composed of a wax or waxy surface on a paper or pasteboard foundation. Heretofore it has been proposed to use soft paper saturated or coated with paraffine as the material for recording by the indenting method; but its use does not appear to have been successful, and an outer layer of tin-foil was therefore employed to receive the indentations.

The invention consists, thirdly, in cutting or engraving the record in the form of a groove with sloping walls, the sound-waves being represented by elevations and depressions at the bottom of the groove or otherwise. The advantage of this form of record is that it forms an efficient guide to the reproducing-style.

The invention consists, fourthly, in loosely mounting the reproducing-style so that it can readily be guided by the record. Preferably the reproducing-style, or rather what may be called the "head" of the reproducing instrument is mounted on an universal joint, and the style is pressed against the record by the yielding pressure of a spring or weight. Practically in the instruments made by us the pressure is due to the weight of the instrument, modified by the elasticity of a section of soft-rubber tube, which supports the same and constitutes a universal joint; but evidently there are many devices which can be used to mount the reproducer, so that it is free to follow the sound record or phonogram, and which, therefore, would be within the spirit of the invention. The reproducing-style, mounted as just explained, is specially adapted for use in connection with a record in the form of a groove with sloping walls, and this combination is specially claimed; but it may also be usefully employed in connection with other forms of record.

The invention consists, fifthly, in reproducing directly from the wax record. It is found that such a record has sufficient strength to withstand the rubbing action of the reproducing-style, so that a considerable number of reproductions can be obtained from it. The smoothness of the wax gives it a great advantage in this regard. So far as we are aware, no one has reproduced sounds from a wax record by rubbing a style or reproducer over it.

The invention consists, sixthly, in a reproducer or reproducing instrument in which the reproducing-style, instead of being placed behind its support, projects at the point beyond the edge thereof. One practical advantage of this is that it enables the position of the style on the record or phonogram readily to be observed.

The invention consists, seventhly, in cutting the sound-record in a fusible material, (the waxy compound before referred to, for example,) and then melting the surface slightly, so as to remove any roughness left by the cutting-style. These roughnesses are altogether outside of the sound-vibrations, and give rise in reproducing to scraping noises, which interfere with the intelligibility of the sounds reproduced. These scraping noises are greater with some other modes of reproducing which we have devised, and which will form the subject of other patents, than they are with a rubbing style; but even with the latter the additional smoothness given to the surface by the partial fusion has some advantage.

The invention consists, eighthly, in a sound-recorder having a cutting or graving style which is held by elastic or yielding pressure against the surface on which the record is to be made. The object is to enable the vibratory graver or cutting style to ride over instead of plowing through any elevations on the recording-surface. The depth to which the point of the cutting-style is embedded in the record affects the amplitude of the style's vibration. By this improvement the depth is kept uniform, notwithstanding any slight unevenness of the recording-surface.

The invention consists, ninthly, in having the recorder, of whatever description, or the reproducer, or both, rest against the tablet or recording material by gravity.

The invention consists, tenthly, in combining, with a sound-recorder or recording-instrument of any suitable description, and specially with one having a cutting-style, a tube or hollow standard on which the recorder is mounted, and through which the sound-waves are conveyed to the same. This part of the invention also consists in supporting this hollow standard on a hinge, and having a sound-conveying tube communicate with the interior thereof through the hinge. This part of the invention further consists in supporting the reproducer or reproducing-instrument on a hollow sound-conveying standard, the same as explained with respect to the recorder, and in similarly connecting the hollow standard of the reproducer with an exterior sound-conveying tube.

The invention consists, eleventhly, in combining with the recorder a mouth-piece so shaped as to include the nose of the user. It is found desirable to concentrate the sound-waves as much as possible upon the recording instrument or style, and if an ordinary mouth-piece be used the sound reproduced from the record is imperfect in the nasal elements, and sounds somewhat like the speech of a person with a cold in his head. By the use of the improved mouth-piece this disagreeable quality of the reproduced sound is avoided.

The invention consists, twelfthly, in a reproducer in which the sonorous vibrations impressed by the record upon the style are by the latter communicated to a block, plate, or other body of hard rubber, and through said body are transmitted to the air or to other vibratory medium. It is found that this material (hard rubber) gives much purer sounds than metal and other substances heretofore employed. It appears to absorb minute vibrations which give rise to scratching noises, and also to communicate sonorous vibrations without at the same time adding any foreign vibrations due to the movements of its own particles among themselves. The result is probably due to the high elasticity and the homogeneity of hard rubber.

The invention consists, thirteenthly, in combining with the disk of a recording and reproducing apparatus, in which the record is formed on the face of said disk in a volute or spiral by cutting or otherwise by any known or suitable means mechanism for giving to said disk a uniform surface-speed under the recorder. Heretofore when the record was formed on the face of a disk the latter has been given a uniform rotation, so that the same number of words were recorded in the outermost circles, as in the smaller inner ones. By giving to the disk a uniform surface-speed under the recorder, or by making the times of each rotation inversely proportional to the distance of the recorder from the center of the disk, the record of any given word or sound will be of the same length at whatever part of the disk it may be, and in this way it is possible considerably to increase the number of words or sounds on a given area.

The invention further comprises certain special constructions, combinations, and arrangements of parts, as hereinafter set forth.

Having now explained the principle of the invention, the manner in which the same is or may be applied will now be explained with reference to the accompanying drawings, which make part of this specification.

Figure 1 is a plan view of an apparatus constructed in accordance with the invention, arranged for recording; Figs. 2 and 3, respectively, a front elevation and cross-section of the same; Fig. 4, a view in section and elevation of the recorder; Figs. 5 and 6, views on an enlarged scale of the graver or cutting style; Figs. 7 and 8, views in elevation and section, respectively, of the reproducer; Figs. 9 and 10, similar views of another form of reproducer, and Fig. 11 an elevation of the sound-conveying tube for use with the reproducer. Figs. 12 to 17 represent a modified form of apparatus, Fig. 12 being a back view, partly in section; Fig. 13, a plan, partly in section; Fig. 14, an edge view, partly in section; Figs. 15 and 16, views in elevation and section of the recorder, and Fig. 17 an edge view of a friction-clamp making part of the apparatus. Figs. 18 and 19 are plan and longitudinal sections, respectively, of a form of apparatus also constructed in accordance with the invention, or with parts thereof in which the record is made on a strip, and Fig. 20 a plan, partly in section, of the reproducer for use with such apparatus. Fig. 21 is a view of a recorder in which the style is operated electrically.

Referring to Figs. 1 to 11, A is the base or bed of the apparatus, and B an upright frame, which carries the mechanism for supporting and moving the tablet F, (shown as a disk,) on which the record is to be or has been formed. In the slide C, movable in ways of the frame B, is journaled an arbor, D, on which are fixed a metal disk, E, at one end and a bevel-gear, 1, at the other. The arbor projects beyond the metal disk E, so as to form a support for the recording-tablet F, which is retained thereon by the nut 2 and washer 3. The metal disk E performs the double function of a friction-wheel and of a backing to the recording-tablet F. The bevel-gear 1 engages a similar gear, 4, on the end of the screw 5, which is journaled in a bearing in the slide C, and is tapped through a stationary lug, 6, on the frame B. As the arbor D is revolved, the screw 5 is turned also, and in consequence of its engagement with the lug 6 it moves the slide C lengthwise of the frame B. The rotation is communicated to the arbor from the shaft 7, journaled in bearings of the frame B, and provided at one end with a fly-wheel, 8, and crank-handle 9, and at the other with a friction-pinion, G. This pinion is formed, as shown, of rubber disks clamped together between metal washers. It bears against the back of metal disk E, and communicates motion to it. As the slide C is moved by the action of the screw 5, the metal disk E is carried past the friction-pinion, so that it touches the metal disk in a spiral line, and serves to give a uniform surface-speed to each part of the disk as it in turn comes opposite said pinion. The recorder H is placed on the opposite side of the metal disk E, preferably as shown, with the point of the graver or cutting-style 11 directly opposite the point where the pinion G touches the disk E. The said pinion thus acts as a support to the disk against the action of the cutting or recording style. The latter is preferably formed of a round wire by turning the end conical and rounding the extremity, and then grinding off one side to the axis of the wire. This leaves sharp cutting-edges on both sides of the tapering point. These edges remove the material in chips or shavings, like a plane or turning-tool. It is not essential to give this form to the style. Any form which will remove the material and not simply displace it will answer. The style is set in one end of a block, 12, provided on the opposite end with a cup, 13, (see Fig. 4,) and secured in the cross-piece 14 by the nut 15. The cross-piece 14 is fastened to a ring, 16, into which a back plate, 17, is secured. These parts, except the steel style, are preferably of hard rubber, although they could be made of another material—of brass, for example. A sound-conveying tube, 18, is screwed into the back plate, 17, the end being just behind the cup 13. A diaphragm, 105, of any suitable material, whose edges are clamped between the ring 16 and back plate, 17, is placed behind the cup 13, which is pressed against said diaphragm by the elasticity of cross-piece 14. The cup 13 and block 12 serve to communicate the vibrations from the diaphragm to the recording-style.

The tube 18 forms part of a hollow standard, upon which the recorder is mounted. The lower part, 19, of this standard is hinged in the bracket 20, as clearly shown in Fig. 2, so that it can be rocked to bring the recorder into or put it out of action.

On the tube or standard 19 is a ring-weight, Z, which is retained in position by a set-screw, 127. It therefore can be adjusted up or down, in order to increase or diminish the pressure of the style 11 against the tablet F. The use of this weight is desirable, but not necessary.

The tube 21 communicates with the interior of the hollow standard through the hinge, and does not therefore interfere with its freedom of motion. This tube 21 can be fixed in the bracket or can be allowed to turn, as may be preferred.

The mouth-piece I is shaped to fit the face of the user, and is provided with a notch, 22, to receive the nose. It is attached to the tube 23, which at its lower end fits snugly in the tube 21 and communicates through the series of tubes 23, 21, 19, and 18 with the space inside and back of the cup 13.

In operation the recorder rests by its own weight, assisted by the pressure of weight Z, or by its own weight alone, if preferred, against the recording-tablet F, said weight causing the style to embed itself to the proper extent in the recording material. The sonorous vibrations impressed upon the style are so rapid, as well as so minute, that the record is made as perfectly as if the recorder were held positively, while at the same time the recorder can be moved bodily to conform to the unevenness of the surface of the tablet, and thus keep uniform the depth at which the style operates.

The tablet F consists of a paper or pasteboard foundation, 24, with a coating, 25, of wax. A composition excellently adapted to the purpose, and according to our experience the best, consists of one part, by weight, of white beeswax and two parts of paraffine. The two bodies are melted together, and if not perfectly free from dirt and grit should be filtered. A filtration through cotton-wool will answer. The coating is or may be about one-twentieth of an inch in thickness, (the paper being one-tenth of an inch, more or less,) and can be made by flowing the melted composition over the paper disk or foundation. The surface is preferably turned off flat on a lathe.

In order to place the tablet in the machine, the recorder H is turned back out of the way. When the tablet has been secured in place, the recorder is turned forward into the position shown, the style resting against and slightly penetrating the wax coating. A penetration of one one-hundredth of an inch has been found very effective, the style being formed of No. 16 wire shaped at the cutting end as in Figs. 5 and 6. Upon turning the fly-wheel 8 the disk E and tablet F will be turned, and the style 11 will cut or engrave a spiral line in the wax coating of the tablet. If one talks into the mouth-piece I, the style will be thrown into vibrations corresponding to the spoken words, and the engraved line will be of varying character, the inequalities or variations from uniformity representing the forms of the sound-waves.

The reproducer K, (shown in Figs. 7 and 8,) for reproducing from the engraved tablet, or from other suitable record the sounds which formed said records, has a reproducing-style, 26, formed of a narrow metal strip bent near the end, as shown in Fig. 8, and pointed, as shown in Fig. 7. This style is held by cementing, riveting, or otherwise, between the strip 27 and the circular plate 28, both preferably of hard rubber. The strip 27 is fastened at the bottom to an offset on the block 29, in which a passage is formed for the sound-waves. This passage terminates just behind the plate 28. There is a fixed disk, 30, of the same size as the movable plate 28. It is cemented or otherwise fastened on the face of the block, and is perforated at the center, in order not to obstruct the opening therein. The plate 28 is close to but not in contact with the disk. The tube 31, fixed at the upper end to the block 29, is joined at the lower end to the tube 33 by a section of soft flexible vulcanized-rubber tubing, 32. For use the tube 33 is slipped into the tube 19 in the manner shown for the tube 18 of the recorder.

The reproducer K when so placed is mounted upon a hollow standard composed of the tubes or tubing 31, 32, 33, and 19, and in consequence of the flexibility of the rubber tubing 32 it is free to follow the record. No special care is necessary to insure its adjustment, for if the reproducer K be allowed to rest against the record with the style upon the engraved line the style will of itself gravitate to the bottom of the groove.

There exists always a liability to disarrangement in some part of the machine either in the recorder or the support therefor or the recording-tablet or its support, or if there be no disarrangement it would be difficult to insure that the reproducing-style should touch the record precisely at the proper point if the reproducer be held rigidly. Difficulties on these accounts are avoided by the loose or flexible mounting of the reproducer, the style automatically adjusting itself to the proper place on the record. It will be seen that the reproducer is mounted on a universal joint, so that it can move in any direction. The movement parallel with the face of the tablet would, however, by itself allow the style to follow and adjust itself to the record to a useful extent.

In operation the reproducer K is placed against the record, and on turning the wheel 8 in the same direction and at about the same speed that it was turned in recording, the record will move the style 26 and plate 28, so as to throw the air in the hollow standard into vibrations, and produce sound-waves similar to those which originally acted upon the recording-style to make the record. The reproduced sounds are audible by placing the ear in proximity to the mouth-piece I; but it is preferred to withdraw said mouth-piece, and to connect the flexible tube 34 (see Fig. 11) with the tube 21 and listen at the ear-piece 35. After the record has been cut it will of course be understood that the machine is turned back to the starting-point for reproducing. The surface of the cut record can be rendered more smooth by removing the engraved tablet from the machine and exposing the surface to heat—as, for example, by rotating the tablet-face downward over an alcohol-lamp until the surface begins to glisten. Of course a too long exposure would destroy the record. It is the merest surface action that is required. The record can be used for reproducing without submitting it to this operation and without removing it from the machine. It may, however, be removed, and at any time thereafter replaced on the same or a similar machine, and be made to reproduce the original sounds.

The reproducer K' (shown in Figs. 9 and 10) has the style 26 attached to the outer of two light plates, 36 and 37, which are attached to a diaphragm, 38, of thin sheet rubber clamped at the edges between the ring 39 and the border of the back plate, 40. The tube 31 is fastened in the back plate.

It will be observed that in both forms of reproducer the style 26 projects beyond the edge or end of the instrument, so that the position of its point on the record can be easily seen.

Referring now to Figs. 12 to 17, A is the bed, B an upright frame, D an arbor, E a metal disk, F the tablet, and G a friction-pinion, as in Figs. 1 to 11. The nut 2 and washer 3, the shaft 7, wheel 8, and crank 9, and the paper disk 24 and wax coating 25 are identical with the parts similarly numbered in Figs. 1, 2, and 3. The arbor D, instead of being journaled in a slide, is carried by an arm, L, which is supported by and is fixed on the short shaft 50. This shaft is supported on centers 51 and 52, so that the arm L can be rocked. The worm-wheel 53, loosely mounted on the shaft 50, is held stationary by the clamp M, the jaws 54 fitting on either side of the wheel, and being pressed against it by the thumb-screw 55. The arbor D carries a screw-wheel, 56, which engages the worm pinion 57 at the upper end of shaft 58. The screw 59 at the lower end of the shaft engages the worm-wheel 53. This shaft 58 and the gears 57 and 59 carried thereby prevent the arm L being turned independently of the worm-wheel 53, except as the said shaft is rotated. As the arbor D, disk E, and tablet F are rotated, the screw 56 turns the shaft 58, and consequently—the worm-wheel 53 being held stationary by the clamp M—the arm L is swung gradually to one side, so that the recorder engraves a spiral line on the wax face of the tablet. When the record has been cut, it is only necessary, in order to restore the tablet to the starting-point for reproducing, to draw back the recorder and to loosen clamp M, when arm L can be moved at once to the proper position.

A recorder constructed and mounted precisely as in Figs. 1, 2, 3, and 4 could be used in this machine; but, as shown, the recording-instrument H′ is modified to some extent. The cutting-style 11 (which is the same as that of Figs. 4 to 6) is set into a block, 60, carried by a metal strip, 61. This is fastened to a block, 62, at the lower end of a back piece, 63, which is attached to the upper end of the tube 64, which forms the hollow standard for the recorder, and which is mounted on the bracket 65, so as to be capable of being turned to put the record into or out of action. The sound-conveying tube 66 corresponding to tube 21 of Figs. 1 and 2 communicates through the hinge with the interior of the tube 64. In front of the opening at the upper end of tube 64 is stretched a diaphragm, 67, of thin sheet metal, or it may be of other membrane or material, its edges being clamped between the ring 68 and back piece, 63, soft-rubber rings 69 and 70 being interposed one on each side of the diaphragm. On the opposite side of the diaphragm 67 from the tube 64 a light plate, 71, of metal cupped in the center, is held against the diaphragm by the pressure of the strip 61, a projection on the back of said strip bearing against the said plate 71.

In this machine the reproducer K, instead of being mounted on the same bracket as the recorder when the latter has been removed, is carried by a separate bracket, 72, the tube 33 being hinged thereto, so that the recorder and reproducer remain, or may remain, always attached to the machine, it only being necessary to turn one or the other into position, as may be required.

Referring to Figs. 18 to 20, A is the base or bed, B an upright frame, 7 the driving-shaft, 8 the fly-wheel, 9 the operating-crank handle, and G the friction-pinion, as in Figs. 1 and 2. The arbor P is supported in an upright position in bearings of the frame A B, and is revolved by the friction-pinion G engaging the friction-disk Q. The record is made on a wax-coated strip, R, of paper, which is passed around the periphery of the disk S in the groove formed thereon. As the strip passes in front of the recorder or reproducer, it is wound off one reel—say the reel T—and upon the other reel, U. The strip can be wound back upon the reel T when desired. Each reel rests by its own weight upon a platform or flange, 75, at the upper end of a hollow shaft, 76, which turns upon a stud, 77, fastened at the base to the bed B. A pin, 78, passes through the center of the reel, and forms a journal for it to turn upon. A nut, 79, holds the reel on, and may be used to bind it with more or less tension. On each shaft 76 is a belt-pulley, 80 and 81, respectively, driven by a crossed belt, 82 or 83, from a pulley, 84 and 85, on the arbor P. These pulleys 84 and 85 are loose upon the arbor, but are provided each with a clutch, 86 and 87, so placed (see Fig. 18) that when the arbor is turned to the left the clutch 87 engages the hub 89 on the arbor, and the pulley 85 is turned therewith, while when turned to the right the clutch 86 engages the hub 88. Each shaft 76 has a stop-clutch, 90 and 91, respectively, which holds it stationary when the strip is being wound on the other reel. Thus, when the arbor P is turned to the left the reel U is revolved in the direction indicated by the arrow, and the sleeve-supporting reel T is held stationary. The strip is thus stretched at all times, the degree of tension depending upon the friction between the reels and their supporting-flanges 75. The recorder H″ is carried by a cross-piece, 92, supported by posts 93. The style 11 is carried by a cross-piece, 94, to which it is attached by means of the cup 95, of hard rubber, which forms a nut on the screw-threaded shank of the style, and said cup rests against a mica diaphragm, 96, whose edges are clamped between the screw-ring 97 and the back plate, 98. The tube 18, screwed into the back plate, is fastened by soldering or otherwise to the cross-piece 92. The tube 23 of the mouth-piece I fits into said tube 18. The ends of the cross-piece 92 are slotted to fit around the screws at the top of posts 93 and rest upon nuts 99, and are clamped by nuts 100. By means of these nuts the vertical position of the recorder can be adjusted. After one line has been engraved on the strip, the recorder can be adjusted to engrave as many additional lines parallel thereto as the strip will receive. The slots in the cross-piece 92 allow the recorder to be moved toward and away from the strip, so as to regulate the depth of the engraved line. To insure a greater nicety of adjustment, screws 101 are tapped through the metal at the closed end of the slots, and bear at the point against the supporting-screws.

The reproducer K', Fig. 20, is similar to that shown in Figs. 9 and 10, except that the style 26 is so placed that the point is at the center instead of projecting beyond the edge of the instrument. Its position on the record is therefore not so readily seen; but with the form of machine shown in these figures this is less important. The same may be said of the loose mounting of the reproducer, although in point of fact the thin rubber diaphragm 38 gives a certain lateral play to the style. The tube 31 is rigidly fastened to a cross-piece, 102, identical with the cross-piece 92, and with said tube 31 the bearing-tube 30 and ear-piece 35 are connected.

The paper strip can be easily coated with the beeswax and paraffine compound by running the same through a body of melted composition and scraping one side, leaving what adheres to the other to harden thereon.

In Fig. 21 an arrangement for operating the recorder by electro-magnetism is shown. The magnet 107 is mounted on a bar, 108, journaled in bearings in standards 109. It is provided with a bobbin, 106, of wire, surrounding the pole piece, which bobbin is included in a circuit over which electrical undulations are caused to pass by any suitable transmitting-instrument—for example, such as commonly employed on telephone-lines. In front of the pole-piece or core of the bobbin is a diaphragm, 105, of magnetic material, whose edges are clamped between the ring 16 and back plate, 17. The cup 13 should always be in contact with diaphragm 105, and is pressed against it by the spring of piece 14. This cup, as well as the style 11, block 12, nut 15, and cross-piece 14, is the same as in the recorder H of Figs. 1 and 4.

It is evident that various modifications other than those indicated can be made and the invention still be employed in whole or in part, and also that parts of the invention may be used separately.

In the foregoing description details have been given with some minuteness. This has been done to furnish the best information in our power for enabling those skilled in the art to make and use the invention, and not with the intention of limiting the invention to the precise dimensions, proportions, shapes, and materials stated.

A means has been shown for impressing vibrations upon the recording-style by an electrical current through the intermediary of an electro-magnet, in a manner similar to that in which the diaphragm of an ordinary receiving-telephone has been vibrated.

It is evident that other means heretofore used for vibrating a diaphragm could be used in place of the magnet; also, it is evident that the vibrations of the reproducing-style could be taken up and transmitted by the means heretofore used for taking up and transmitting vibrations, (those of a telephone-diaphragm, for example.)

The term "cutting" is herein employed to indicate an action in which the material is removed in chips, shavings, or other small pieces—as in engraving, turning, and the like—and not simply displaced.

The displacement of the material is not only a different operation from the cutting contemplated by this invention, but is not calculated to accomplish the objects for which cutting or graving is employed.

Having now fully described our said invention and the manner in which the same is or may be carried into effect, what we claim is—

1. The method of forming a record of sounds by impressing sonorous vibrations upon a style, and thereby cutting in a solid body the record corresponding in form to the sound-waves, in contradistinction to the formation of sound-records by indenting a foil with a vibratory style, or cutting a strip by vibrating it against a revolving disk-cutter, substantially as described.

2. The method of forming a sound-record by impressing the sonorous vibrations upon a style in a direction at right angles to the recording-surface, and thereby cutting in a solid body a series of elevations and depressions of varying depth, corresponding in form to the sound-waves, substantially as described.

3. The vibratory cutting-style of a sound-recorder, substantially as described.

4. The cutting-style, in combination with a support permitting the same to be vibrated, and means for impressing sonorous vibrations thereon, substantially as described.

5. A vibratory cutting style, in combination with a sound-conveying tube for concentrating the sound-waves upon the style, substantially as described.

6. A vibratory cutting-style, in combination with a tablet or other solid body in which the record is to be cut, and mechanism for supporting the same and moving it with reference to the said style, substantially as described.

7. A sound-record consisting of a tablet or other solid body having its surface cut or engraved with narrow lines of irregular or varied form corresponding to sound waves, substantially as described.

8. A sound-record consisting of a tablet or solid body having its surface cut or engraved with a number of lines of variable cross-section, the irregularities or variations corresponding in form to sound-waves, substantially as described.

9. The method of forming a sound or speech record which consists in engraving or cutting the same in wax or a wax-like composition, substantially as described.

10. The sound or speech record cut or engraved in wax or a wax like composition, substantially as described.

11. The recording-tablet of a phonograph or sound-recording machine, having as the material for recording sounds or sonorous vibra-

tions the composition of beeswax and paraffine, substantially at described.

12. The sound or speech record cut or engraved in a wax like composition, such as the compound of beeswax and paraffine, substantially as described.

13. A tablet or body for recording sound-vibrations, consisting of a paper or pasteboard foundation and a surface-coating of beeswax and paraffine compound, substantially as described.

14. The sound or speech record cut or engraved in a wax-like composition, such as the described compound of beeswax and paraffine, constituting a surface-coating to a paper or pasteboard foundation, substantially as described.

15. The method of making a sound or speech record which consists in engraving or cutting in the recording material an irregular groove with sloping walls, the shape of the groove representing the sound-vibrations, substantially as described.

16. The method of making a sound or speech record which consists in cutting in the recording material a groove with sloping walls and of variable cross-section, the variations corresponding in form to sound-waves, substantially as described.

17. The sound-record in the form of an irregular groove with sloping walls cut in solid material, substantially as described.

18. The sound-record cut in wax or wax-like composition in the form of an irregular groove with sloping walls, substantially as described.

19. The combination, with a reproducing-style, of a mounting therefor, which leaves said style-face to move laterally, and thereby adjust itself automatically to a sound-record, substantially as described.

20. The reproducer loosely mounted on a suitable support, so that the reproducing-style is capable of a lateral movement, and may in consequence thereof adjust itself automatically on the record, substantially as described.

21. The reproducer mounted on a universal joint and held against the record by yielding pressure, substantially as described.

22. The combination, with a grooved tablet or other body having a sound-record formed therein, of a reproducer having a rubbing-style loosely mounted, so that it is free to move laterally, and thus adjust itself to the groove, substantially as described.

23. The combination, with the tablet or other body having the sound record formed therein as an irregular groove with sloping walls, of a reproducer having a style for rubbing over said record and mounted on a universal joint, substantially as described.

24. The combination, with a sound-record formed in wax or a wax-like material, of a reproducer having a rubbing style for receiving sonorous vibrations from said record, substantially as described.

25. A reproducer having a style projecting beyond the edge or end of the instrument, so that the position of the point of the style on the record may readily be seen, substantially as described.

26. In a reproducer, the combination, with a vibratory plate or diaphragm, of a reproducing-style fastened flatwise on said plate or diaphragm and bent at the end, substantially as described.

27. The method of recording and reproducing sounds by cutting the record in a wax or wax-like material, and then rubbing over the record the style of a suitable reproducing instrument, so as to impress sonorous vibrations on said style, substantially as described.

28. The method of improving a sound-record which consists in producing an incipient fusion of the surface, substantially as described.

29. The improvement in preparing a sound-record, consisting in cutting the record in a fusible material, and then producing an incipient fusion of the surface, substantially as described.

30. The sound-recorder having a vibratory cutting-style held against the recording material by yielding pressure, substantially as described.

31. The recording-instrument having a vibratory cutting-style and mounted on a hinged arm, substantially as described.

32. The combination, with the tablet or body in which the sound-record is to be made, of the recording-instrument mounted on a hinged arm and resting by gravity against the tablet, substantially as described.

33. The recorder mounted on a hollow arm or standard, which constitutes also a sound-conveyer, substantially as described.

34. The recorder mounted upon an arm or standard hinged to its bracket or base, and provided with a sound-conveyer extending lengthwise of said arm, substantially as described.

35. The recorder mounted upon a hinged arm, and combined with a sound-conveyer which extends lengthwise of the arm, and is connected at the hinge with an exterior sound-conveyer, substantially as described.

36. The reproducer mounted upon a hollow standard which forms a sound-conveyer, substantially as described.

37. The reproducer mounted on a hinged arm, and provided with a sound-conveyer extending lengthwise of said arm, substantially as described.

38. The reproducer mounted on a hinged arm, and provided with a sound-conveyer extending lengthwise of said arm, and connected at the hinge with an exterior sound-conveyer, substantially as described.

39. The combination, with a sound-recorder, of a mouth-piece shaped to surround the mouth and nose of the user, and to concentrate the sound upon the recording devices, substantially as described.

40. The combination, with the tablet, in the form of a disk, and a recorder or reproducer,

of mechanism for causing a spiral line to be traced on the disk by the recorder or reproducer at a uniform surface-speed, substantially as described.

41. The combination, with the tablet, in the form of a disk, the arbor, and the metal disk operating as a friction-wheel, of the slide, or its equivalent, such as herein shown, in which said arbor is journaled, and the friction-pinion for revolving said disk, substantially as described.

42. The combination, with the recorder or the reproducer, the disk, the arbor, and the laterally-movable support to the arbor, of the friction-pinion placed behind and bearing against the disk at a point opposite the recorder or reproducer, substantially as described.

43. The combination, with a recording-style and the support therefor, of a cup on the back of said support, and the sound-conveying tube terminating just behind the cup, substantially as described.

44. In combination with the style of a sound-reproducer, a vibratory body or plate of hard rubber, upon which vibrations are impressed by said style, and through which they are transmitted, substantially as described.

45. A tablet provided with a wax or wax-like coating, and having engraved in said coating a spiral line with inequalities or irregularities corresponding in form to sound-waves, substantially as described.

46. A tablet provided with a coating of wax or wax-like composition, and having a sound-record engraved in said coating, said engraved coating having the glazed surface which results from an incipient fusion of the wax after cutting or engraving the record, substantially as described.

47. In combination with a sound-recorder, a flaring mouth-piece shaped to fit over the face of the user and to include his nose, and communicating through a tube or contracted opening with the space behind the diaphragm of said recorder, substantially as described.

In testimony whereof we have signed this specification in presence of two subscribing witnesses.

CHICHESTER A. BELL.
SUMNER TAINTER.

Witnesses:
PHILIP MAURO,
C. J. HEDRICK.

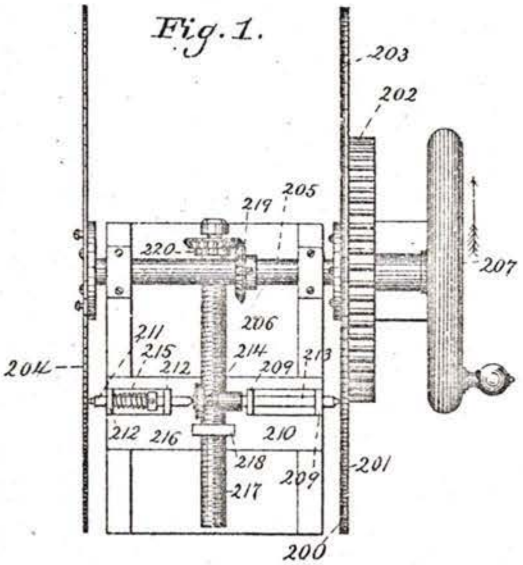
(No Model.) 3 Sheets—Sheet 1.

S. TAINTER.

RECORDING AND REPRODUCING SOUNDS.

No. 341,287 Patented May 4, 1886.

Fig. 1.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201
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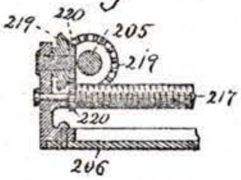
200

Fig. 1^a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219
217
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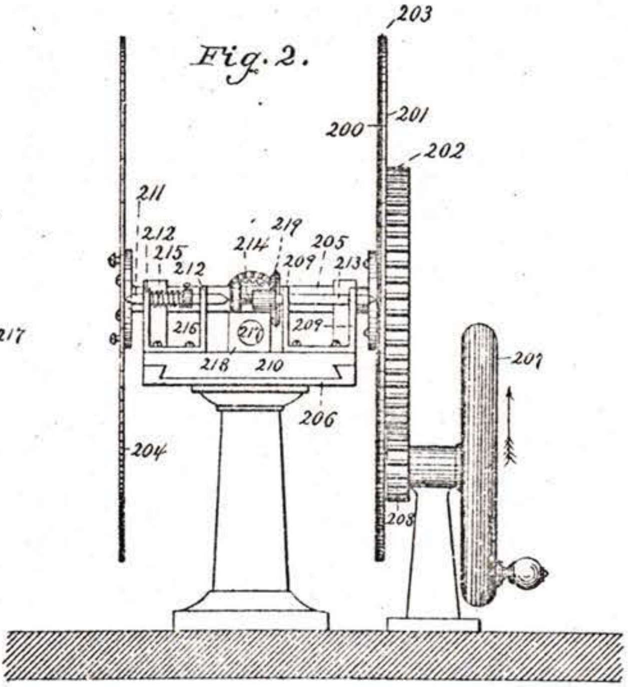
206

Fig. 2.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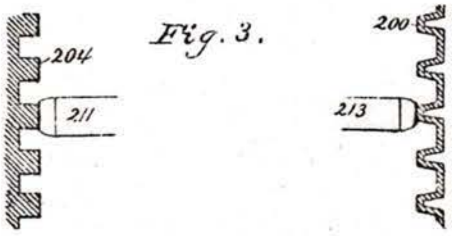
208

Fig. 3.


204
211
200
213

Witnesses
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John C Parker

Inventor
Sumner Tainter
by A. Pollok.
his attorney.

(No Model.) 3 Sheets—Sheet 2.

S. TAINTER.

RECORDING AND REPRODUCING SOUNDS.

No. 341,287. Patented May 4, 1886.

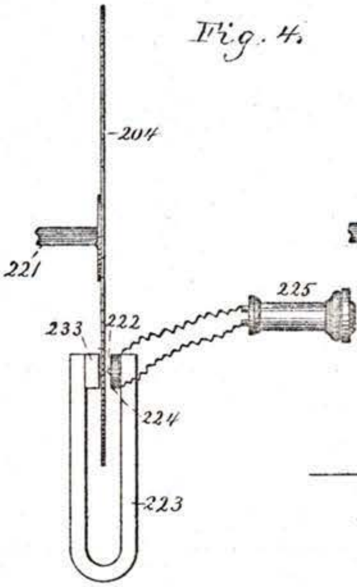
Fig. 4.
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221
225
233
222
224
223

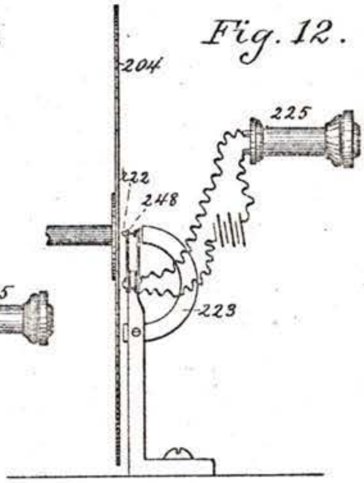
Fig. 12.
204
225
222
248
223

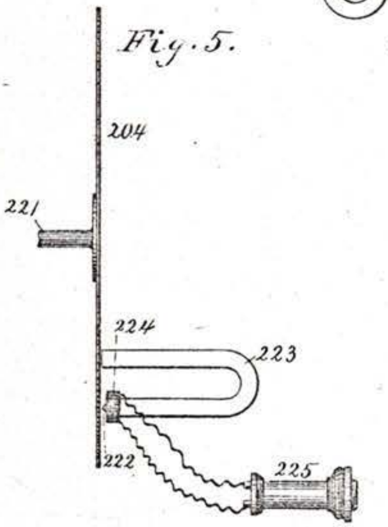
Fig. 5.
204
221
224
223
222
225

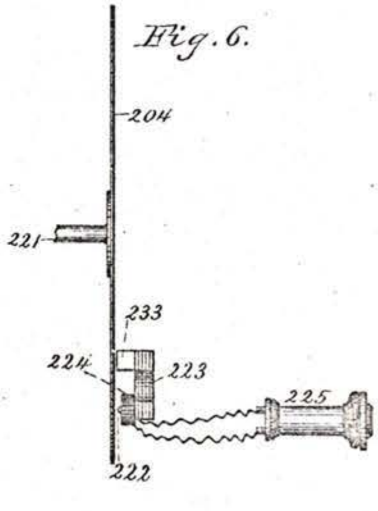
Fig. 6.
204
221
233
224
223
225
222

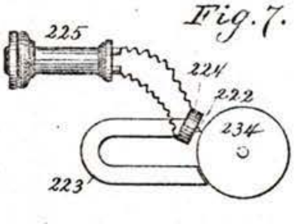
Fig. 7.
225
224
222
234
223
223

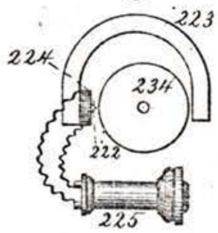
Fig. 8.
223
224
234
222
225

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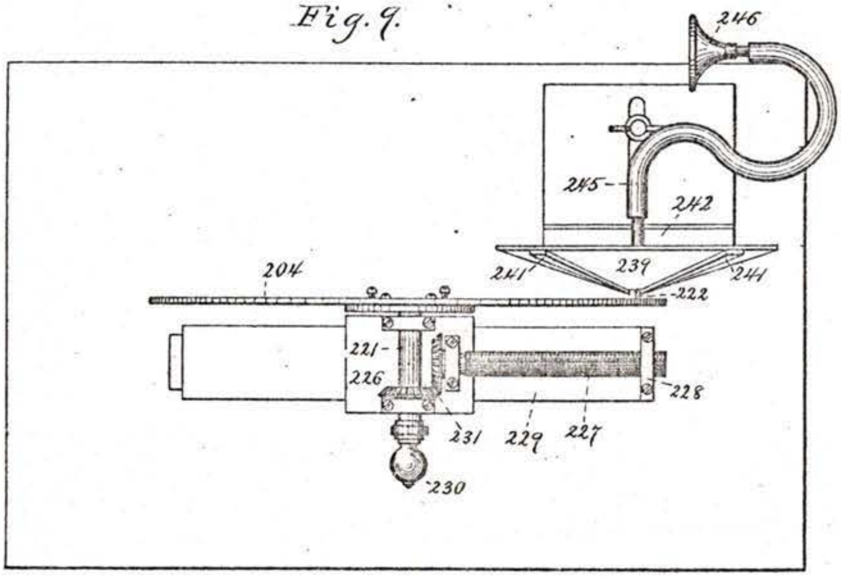
(No Model.) 3 Sheets—Sheet 3.

S. TAINTER.

RECORDING AND REPRODUCING SOUNDS.

No. 341,287. Patented May 4, 1886.

Fig. 9.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239
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204
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226
228
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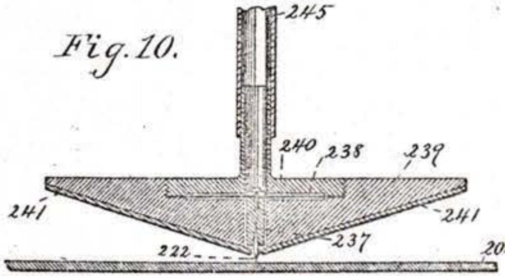
229
227
230

Fig. 10.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238
239
241
241
237
222
204

Fig. 11.

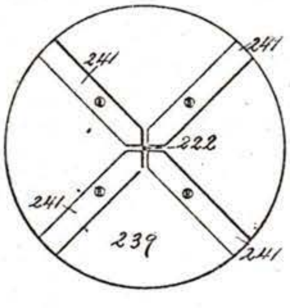
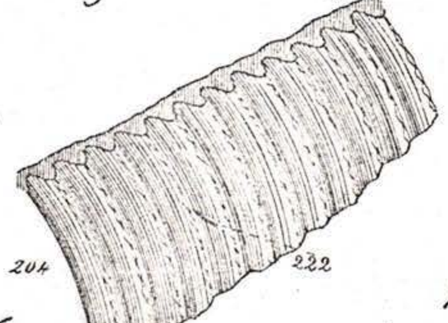

241
241
222
241
239
241

Fig. 13.



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UNITED STATES PATENT OFFICE.

SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA.

RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 341,287, dated May 4, 1886.

Application filed August 29, 1885. Serial No. 175,610. (No model.)

To all whom it may concern:

Be it known that I, SUMNER TAINTER, of Washington, in the District of Columbia, have invented a new and useful Improvement in Recording and Reproducing Sounds, which improvement is fully set forth in the following specification.

This invention relates to the reproduction, through the action of magnetism, of sounds by means of records in solid substances. For this purpose it is necessary, first, to prepare the record in a suitable material, (magnetic or diamagnetic.) The material specially adapted to the purpose is of course iron, (using the word broadly as including steel and various grades of iron.) Owing to the hardness of iron, it is not practical to cut the record directly therein by means of a cutting-style vibrated by the action of the voice, as described in application for Letters Patent of the United States of Chichester A. Bell and Sumner Tainter, filed June 25, 1885, and officially numbered 170,044. The same property would interfere with the preparation of records by the Edison method of indenting, which method is, moreover, inferior to the cutting method in sharpness and in compactness of the record.

According to the present invention the record is first cut in a comparatively soft material, (preferably wax or a waxy composition,) and from an electrotype of this or from other suitable record a copy is made in iron or other suitable material by means of a graver or cutting-style which is actuated by the record to be copied. The wax record would not ordinarily have sufficient strength to withstand the pressure to which it would be subjected in cutting the metal, and for this reason the electrotype is made.

Another method of preparing a magnetic record would be to plate a thin film of iron upon an electrotype taken from the wax or other suitable record.

Having prepared a suitable magnetic record, it is necessary to provide means sufficiently sensitive to respond to the record. Heretofore it has been proposed to attach a magnetized needle to a diaphragm and to support the latter so that the point of the needle is in close proximity to the record, (which it was proposed to form by indenting an iron foil.) In the present invention, in addition to the means before stated for improving the quality of the record, means are provided for increasing the sensitiveness of the receiving-instrument.

Instead of depending wholly upon the permanent magnetism of the needle, one or more inducing-magnets are employed, and the record itself is or may be rendered magnetic by induction or permanently. It is also found that excellent results can be obtained by inducing currents in an electric circuit which includes a receiving-telephone. For this purpose a coil should surround the reproducing-needle. Good results have also been secured by means of mechanical receiving devices without the introduction of electric currents.

Instead of inducing magneto-currents in the receiving-circuit, an electric current can be undulated by variations in resistance produced by the vibrations of the needle.

In the accompanying drawings, Figures 1 and 2 are a plan and a front elevation, respectively, of the apparatus for engraving the iron record; Fig. 1^a, a partial view in vertical section, and Fig. 3 a diagram illustrating in plan and horizontal section the forms of the copying-tools and of the electrotype and the iron tablet on which the record is to be made. Figs. 4, 5, 6, 7, and 8 are partial views in elevation of different forms of magneto-electric reproducers constructed in accordance with the invention. Fig. 9 is a plan of a magneto-mechanical reproducer, also constructed in accordance with the invention, or with parts thereof; Figs. 10 and 11, detail views showing in section and front elevation, respectively the principal parts of the reproducer. Fig. 12 is a view showing an arrangement in which the magnetic reproducing-needle is connected with the electrodes of a contact-telephone; and Fig. 13 is an illustration of an iron record in perspective and section, the point of the reproducing-needle being shown in position.

In preparing the iron record according to the best mode to me known, the record is first cut in wax or a waxy composition, as described in the before-mentioned application; but the cutting-style, which is attached to a vibratory diaphragm, has preferably a flat or chisel-like point, so that the recording-tablet is engraved with a spiral groove of trapezoidal cross-section, the elevations and depressions at the bottom of the groove representing the forms of the sound-waves which act successively upon the diaphragm of the recording-instrument. As the recording-instrument, tablet, and accessories are fully set out in the before-mentioned application, it is considered unnecessary to repeat them here. From this original wax record an electrotype is taken in copper by known methods—that is to say, the surface of the wax is coated with black-lead, or is otherwise rendered conductive, and is then placed in an electro-plating cell. The electrotype, when of sufficient thickness, say twenty-five one-thousandths of an inch, (0.025,) is removed from the wax and mounted on a backing, with a thin layer of plaster interposed. As shown in Figs. 1, 2, and 3, the electrotype 200 is mounted on a metal disk, 201, provided with a gear-wheel, 202, at the back. Ground plaster-of-paris is mixed to a thick emulsion with water and applied between the electrotype and the supporting-disk, which are then pressed together until the plaster hardens. The layer of plaster is indicated at 203. The electrotype is of course the counterpart of the original wax phonogram, with the elevations and depressions at the top of a spiral ridge, instead of at the bottom of a groove.

In order to prepare the iron disk 204 for engraving the record thereon a spiral groove is turned in the face of said disk, forming a spiral ridge of the cross-section shown in Fig. 3. The iron disk 204 and the electrotype 200, with its backing 201, are mounted at opposite ends of the shaft 205, being, as shown, bolted to a flange thereon. The shaft 205 is journaled in bearings of the frame 206. It and the disks attached thereto are revolved by means of a crank-wheel, 207, on an independent short shaft, which carries a pinion, 208, engaging the gear-wheel 202 on the disk 201. The slide 210, mounted in ways of the frame 206, carries the graver or cutting-tool 211, it being mounted in guides 212, so that it can be moved toward and away from the iron disk or tablet 204. It is moved toward the iron disk by the electrotype 200, which rubs against the end of the follower 213, the latter being in the form of a square rod sliding in guides 209 on the slide 210. The screw 214 is tapped into the enlarged end of the follower, and the inner or right-hand end of the cutting-tool rests against the end of the screw. A spiral compression-spring, 215, interposed between a collar, 216, on the cutting-tool and left-hand guide 212, tends to press the cutting-tool against the screw 214, and consequently to hold the follower 213 in contact with the electrotype. By turning the screw 214 the cutting-tool can be adjusted to cut to the desired depth. It is a flat-nose tool, and has its point opposite and in contact with the ridge on the iron disk, as shown in Fig. 3. The outer (right-hand) end of the follower is beveled on the four sides, leaving a rounded edge, as shown in Fig. 3, which makes contact with the ridge on the electrotype. The elevations on the electrotype 209 move the follower 213 and cutting-tool 211, so as to take a chip of corresponding depth from the ridge on the iron disk 204. The depressions on the electrotype allow the spring 215 to move the follower and cutting-tool to the right, so that a smaller chip or none at all is taken from the iron ridge. Thus the counterpart of the elevations and depressions on the electrotype is formed on the iron disk. The record engraved on the latter, therefore, is like the original wax record from which the electrotype was taken.

The slide 210 is engaged by a screw 217, which revolves in a bearing in the frame 206, so constructed as to prevent endwise motion of the screw. The screw is tapped through an ear, 218, on the slide. It is connected with the shaft 205 by the bevel-gears 219 and spur-gears 220. Thus at each revolution of the disks the slide is drawn forward a distance equal to the pitch of the spiral ridges on the electrotype and iron disk.

If the iron be too hard, or if for other reason it is not desired for it to be cut to the full depth at one operation, the cutting-tool can be adjusted by the screw 214 first to cut shallow, and then, when the parts have been returned, adjusting it and causing it to cut deeper, and so on until the desired depth is reached.

Having obtained the engraved magnetic tablet, it is mounted on the shaft 221 of a reproducing-instrument. As shown in Fig. 4, the reproducing-needle 222 is mounted on one pole of a horseshoe-magnet, 223, the other pole of which is placed directly opposite, the magnetic record intervening. A pole-piece, 233, brings the pole close to the back of the tablet or disk 204. Thus the needle and the record or tablet are both magnetized by the induction of the magnet. From the proximity of the poles the intensity of the field is very considerable. The needle (which may be of any suitable size and shape, but should terminate in a point or edge, and be either of soft iron or steel) is surrounded by a bobbin, 224, of fine insulated wire. The telephone 225 (shown as the hand-telephone in common use) is included in circuit. The reproducing-needle has its point opposite the ridge on the tablet and in as close proximity thereto as possible without touching. Fig. 13 shows the position, the record being formed by elevations and depressions on the top of the ridges, which are rounded instead of square, as in Fig. 3. As the tablet or iron disk 204 is revolved, the elevations and depressions on the ridge successively come opposite the needle-point and produce changes in the magnetic field, which in turn induce currents in the bobbin 224 and telephone 225. Sounds corresponding to these changes, and consequently also to the record on the iron disk or tablet, are emitted by the telephone.

Any ordinary or suitable mechanism may be employed for causing the needle to follow the spiral ridge or record on the tablet or disk

204—as, for example, that shown in Fig. 9, wherein the shaft 221 is mounted on a slide, 226, which is connected by the screw 227 with an ear, 228, on the frame 229, (the screw revolving in a bearing on the slide, and being tapped through the ear 228,) so that as the shaft 221 is turned by the crank 230 the screw 227 is revolved by the bevel-gears 231, and the disk 204 is given a translatory as well as a rotary motion.

In Fig. 5, instead of having the tablet or disk interposed between the poles of the magnet, both the poles are opposite the face of the tablet. In Fig. 6 the arrangement is similar, except that the side instead of the ends of the magnet is turned toward the tablet.

In Figs. 7 and 8 the tablet is shown as a cylinder, 234. The magnet in Fig. 7 has both poles on the same side of the cylinder, while in Fig. 8 it spans the same. The surface of the cylinder should be engraved the same as described for the disk 204, and the cylinder can be operated by the well-known means employed in the ordinary Edison phonograph, or by other suitable mechanism.

In the arrangement shown in Figs. 9, 10, and 11 the needle 222 is set in a holder, 237, of non-magnetic material, (preferably hard rubber,) which is attached to the center of a thin diaphragm, 238, (see Fig. 10,) which is confined at the edges by and between the block 239 and screw-plate 240. A series of four bar-magnets, 241, are secured on the face of block 239, with their like poles in proximity to the needle 222, so as to magnetize the same, or to increase its magnetism by induction. The ends of the magnets are pointed, as shown in Fig. 11. The block 239 is mounted upon a bracket, 242, which is adjustably secured in place by means of a screw passing through a slot in the base of the bracket and engaged by a set-nut. The screw-plate 240 is perforated, and the round conveying-tube 245, provided with an ear-piece, 246, is in communication with the space behind the diaphragm through the perforation. The bracket 242 having been adjusted to bring the needle-point in the desired proximity to the tablet or disk 204, the latter is revolved. The variations in the surface of the tablet cause variations in the magnetic field, and produce a varying attraction of the magnetized needle, and consequently throw the diaphragm 238 into vibrations, which in turn are communicated to the air in the tube 245, and by it conveyed to the ear of the listener.

In Fig. 12 the varying attraction between the needle and the tablet produces variations in pressure between the electrodes 248 of a microphone or contact-telephone, and thereby produce undulations in the current passing from one electrode to the other. These electrical undulations are converted into sound-waves by an ordinary receiving-telephone.

It is evident that modifications may be made in details without departing from the spirit of the invention, and parts of the invention may be used separately. The preparation of an engraved iron record and the magnetic reproduction of sounds from such engraved record constitutes an important feature of the invention; yet as certain features in the reproducing means described are new in and of themselves it is not designed to limit the invention to the use of such means in combination with the engraved record. In like manner the engraved iron record is believed to be new in and of itself; also, the means for transferring from one tablet to another by means of a cutting-tool, although designed expressly for the production of engraved iron records, are believed to possess novelty, irrespective of the nature of the material used.

Having now fully described the said invention and the manner of carrying the same into effect, what I claim is—

1. The improvement in the reproduction of sounds by records in solid substances, consisting in engaving or cutting the record in magnetic material, causing by means of such record corresponding variations in the field of a magnetized needle, and converting the magnetic variations into sound-waves, substantially as described.

2. The method of producing a magnetic record by first cutting the record in a soft matetial—such as wax—and then producing from such original a copy in the magnetic material, substantially as described.

3. The method of producing an engraved record in magnetic material by preparing a record in a softer material, and then causing said record or a copy of the same to impress movements corresponding to sound-vibrations upon a cutting-tool in contact with the said magnetic material, substantially as described.

4. The method of copying sound-records by causing the record which is to be copied to impress movements corresponding to the recorded sound-waves upon a cutting-tool, and thereby engraving or cutting out a similar record in the surface of a suitable tablet, substantially as described.

5. The method of reproducing sounds from magnetic records by causing said records to produce changes in the field of a magnetized needle, and thereby inducing electric currents in a coil in said field, and converting said currents into sound-waves, substantially as described.

6. An engraved sound-record in magnetic material, substantially as described.

7. A sound-record in magnetic material having a spiral ridge, the irregularities constituting the record being formed in the top of the ridge, substantially as described.

8. A tablet of magnetic material having a spiral groove turned in the surface thereof, and a sound-record formed in the top of the ridge between the convolutions of the groove, substantially as described.

9. The combination, with a sound-record in magnetic material, of a magnet or magnets and

a magnetic reproducing-needle in the field of said magnet or magnets, substantially as described.

10. The combination, with a magnetized sound-record, of a magnetic reproducing-needle, said record being magnetized independently of any magnetism induced therein by the needle, substantially as described.

11. The combination, with a magnetic record, the magnetic reproducing-needle, and the inducing magnet or magnets, substantially as described.

12. The combination, with a magnetic record, of a magnetized reproducing-needle, a bobbin of insulated wire in the field of said needle, and a telephone-circuit including the bobbin, substantially as described.

13. The combination, with an engraved record in magnetic material, of the magnetized reproducing-needle, substantially as described.

14. The combination, with a tablet having a record formed therein and a tablet for receiving a record, of a follower having a fine though blunt edge for rubbing over the record, a non-rotating cutter movable with said follower for engraving the record in the second tablet, and mechanism for revolving said tablets and causing the follower to follow the record, and the cutter to trace a spiral line upon the second tablet, substantially as described.

15. The combination, with the two tablets and the operating mechanism, of the follower having a fine though blunt edge for rubbing over the record, the spring for holding it against the record, the non-rotatory cutter, and the adjustable connection between the follower and the cutter to enable the depth of cut to be regulated, substantially as described.

16. The method of preparing sound-records, consisting in first cutting the record in a soft material—such as wax—by the action of sound-waves upon a vibratory cutting-style, and then causing said wax record or a copy of the same to impress corresponding vibrational movements upon a graver or cutting-tool in contact with a record-tablet, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

SUMNER TAINTER.

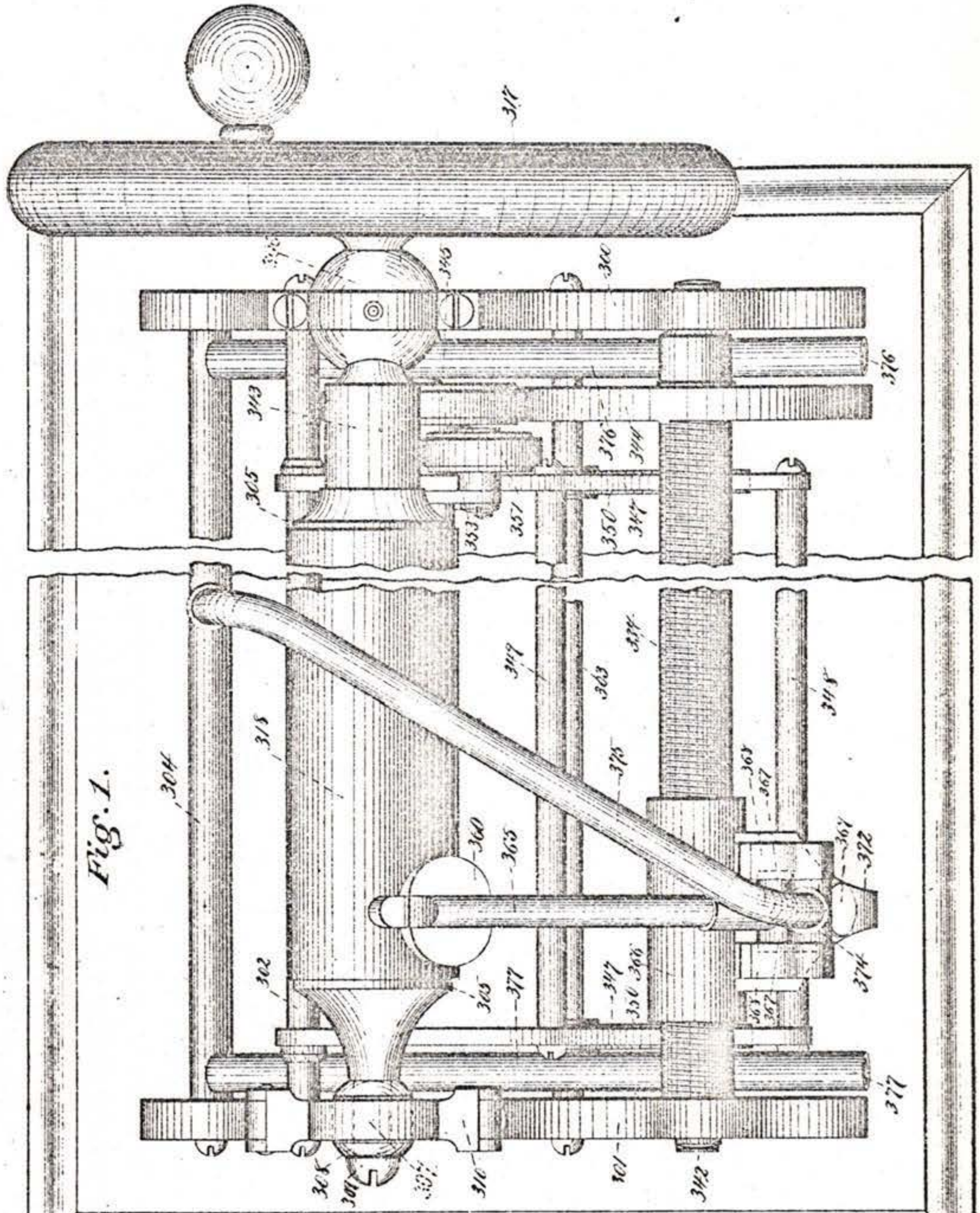
Witnesses:
PHILIP MAURO,
C. J. HEDRICK.

(No Model.) 5 Sheets—Sheet 1.

S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

No. 341,288. Patented May 4, 1886.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342

Fig. 1.

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Philip Mauro

Inventor
Sumner Tainter by
A. Pollok
his attorney.

(No Model.) 5 Sheets—Sheet 2.

S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

No. 341,288. Patented May 4, 1886.

Fig. 17.

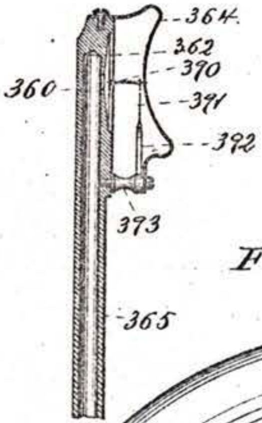
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Fig. 8.

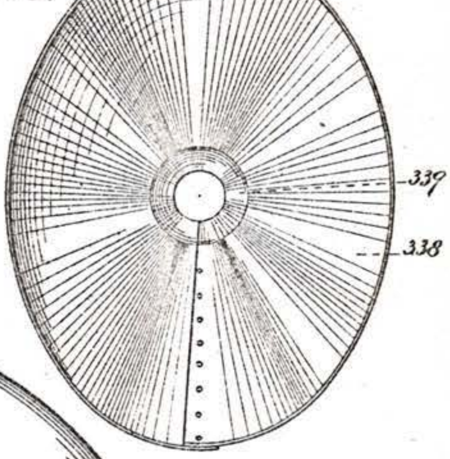
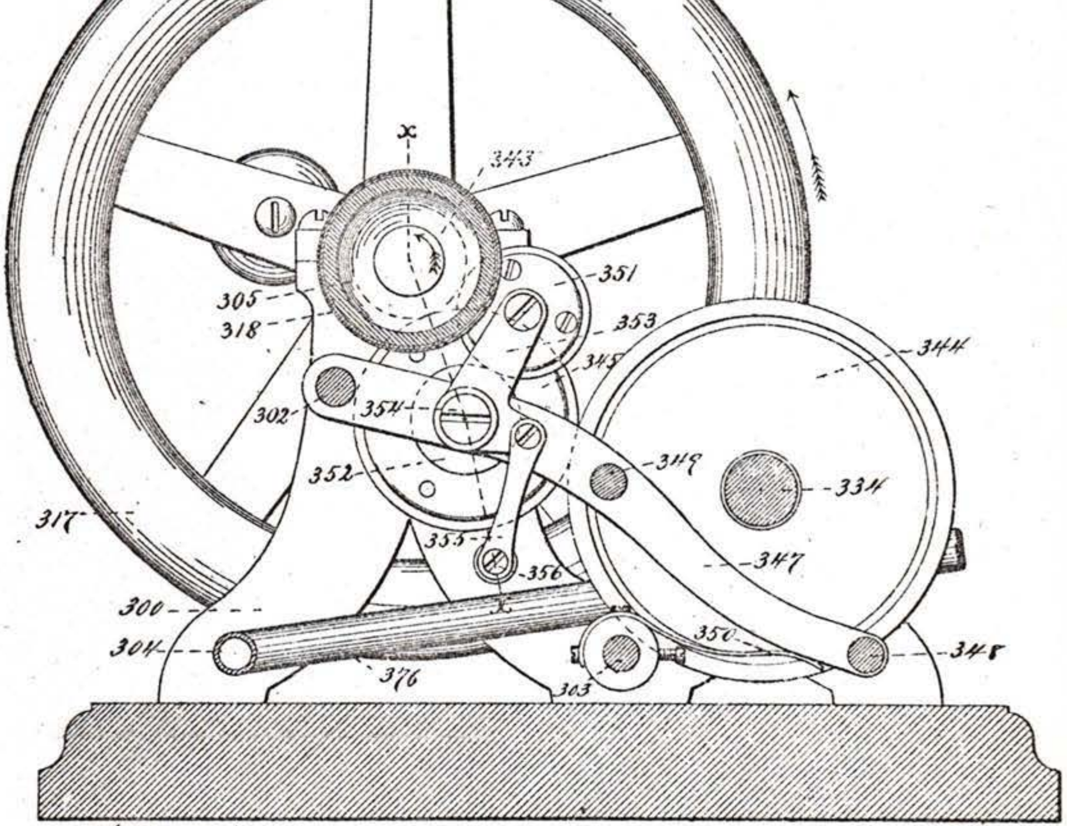


Fig. 2.


x
343
351
305
318
353
345
344
302
354
349
334
352
317
355
356
347
300
x
304
350
348
376
303

Witnesses

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(No Model.) 5 Sheets—Sheet 3.

S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

No. 341,288. Patented May 4, 1886.

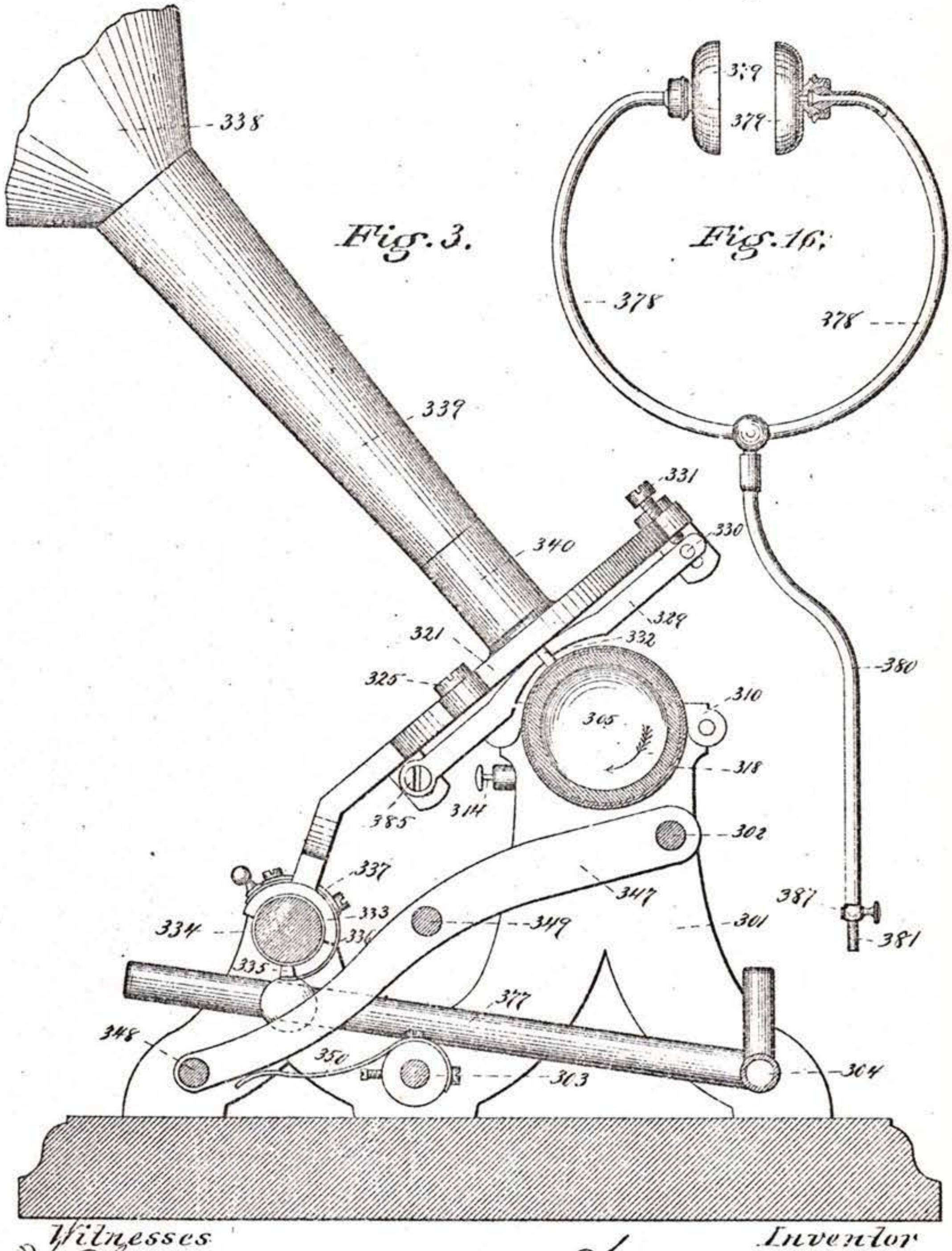

Fig. 3.

Fig. 16.

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S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

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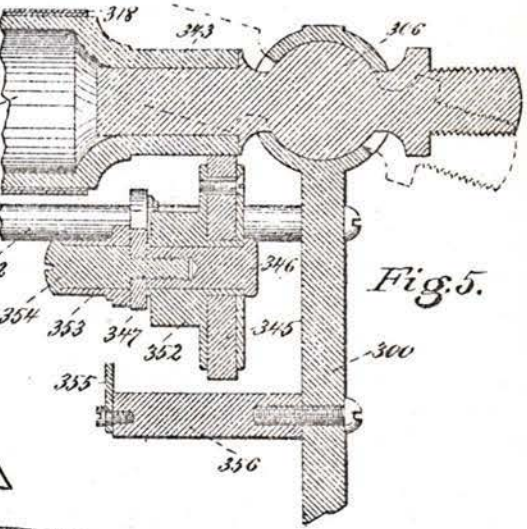
318
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Fig. 5.

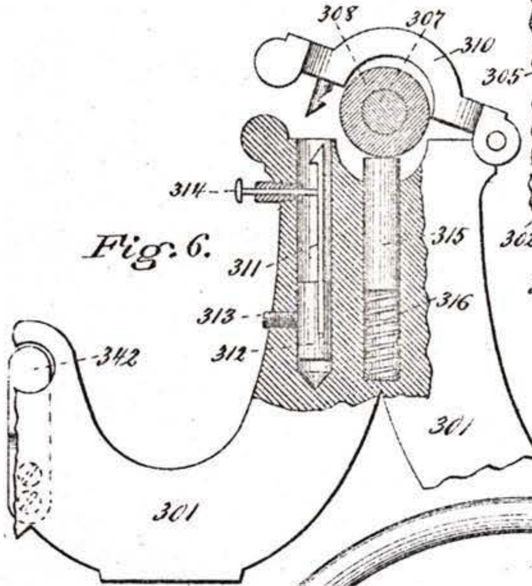
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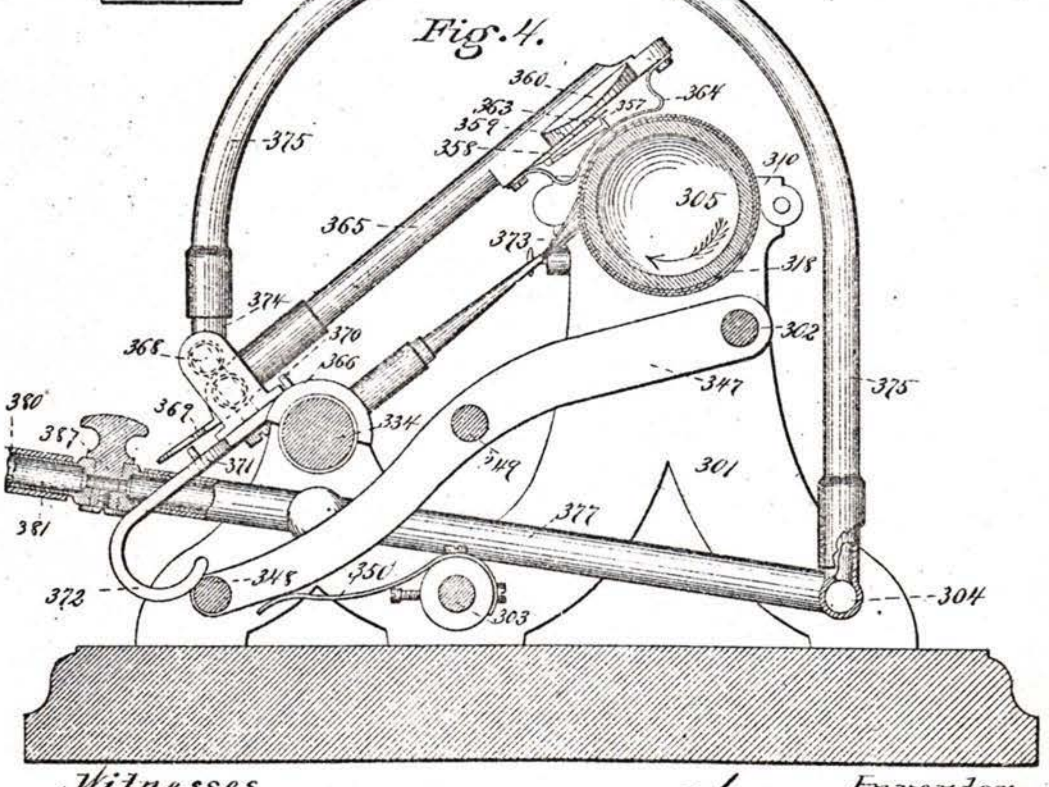
Fig. 6.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303

Fig. 4.

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(No Model.) 5 Sheets—Sheet 5.

S. TAINTER.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

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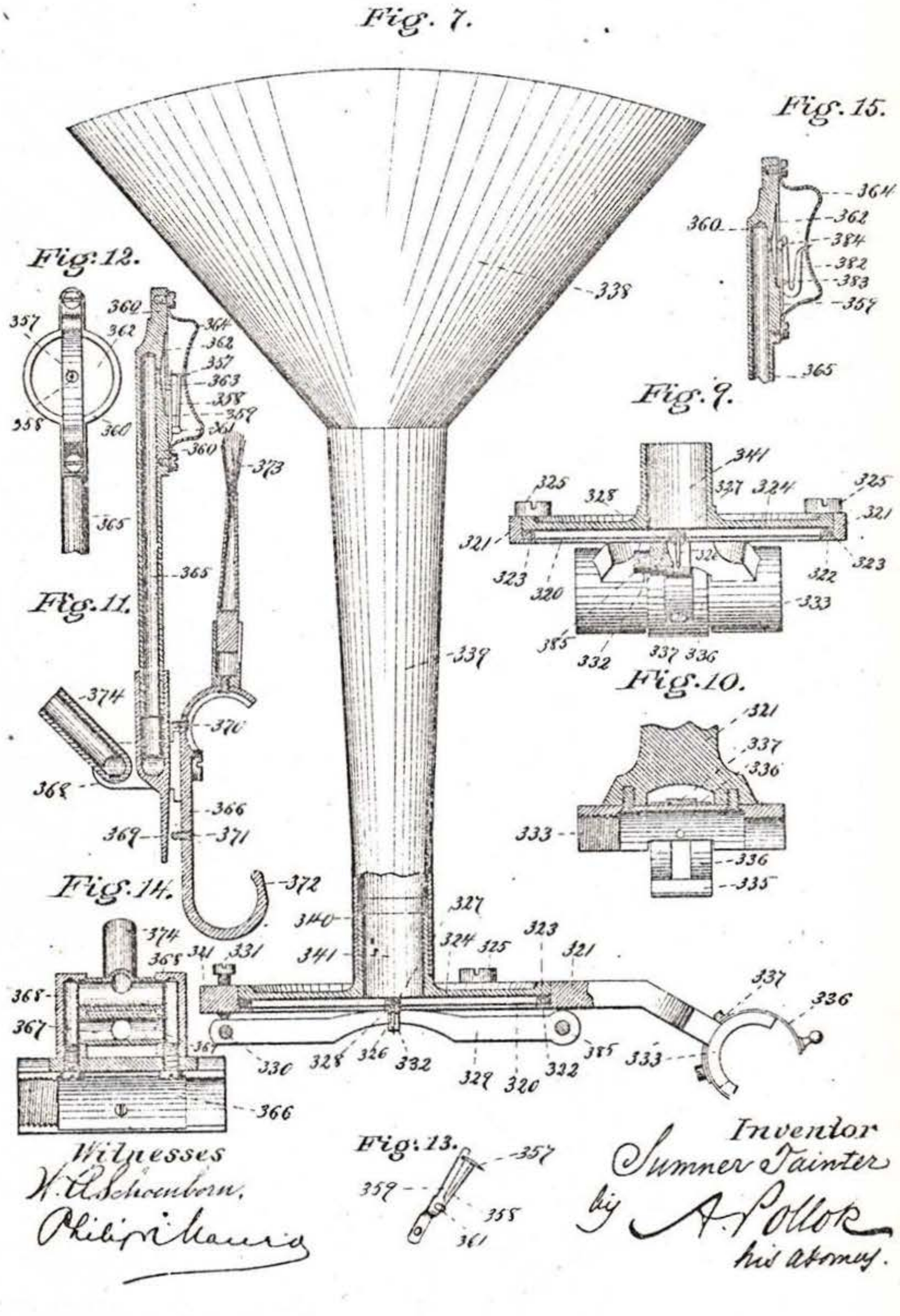

Fig. 7.
Fig. 9.
Fig. 10.
Fig. 11.
Fig: 12.
Fig: 13.
Fig. 14.
Fig. 15.
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UNITED STATES PATENT OFFICE.

SUMNER TAINTER, OF WASHINGTON DISTRICT OF COLUMBIA.

APPARATUS FOR RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 341,288, dated May 4, 1886.

Application filed December 4, 1885. Serial No. 184,656. (No model.)

To all whom it may concern:

Be it known that I, SUMNER TAINTER, a resident of Washington, in the District of Columbia, have invented a new and useful Improvement in Apparatus for Recording and Reproducing Sounds or Sonorous Vibrations, which improvement is fully set forth in the following specification.

This invention has for its object to increase the general efficiency of apparatus for recording and reproducing speech and other sounds, commonly known as "phonographs;" and it consists, principally, in the following improvements:

First. A new recording-tablet is employed. It consists of a hollow cylinder or tube of paper, or other suitable material, coated with wax or wax-like composition, preferably a compound or mixture of beeswax and paraffine. The record is cut in the coating. The advantages of this form of tablet are that it may be very light while having sufficient stiffness to retain its form and avoid the danger of cracking the coating, that it is compact and adapted for transmission through the mails or otherwise, that the recording-surface is continuous, and that it can very readily be placed on and removed from the holder by which it is supported and rotated in recording and reproducing.

Second. The tablet-holder is made in the form of a cylinder, over which the tubular tablet can be forced or slipped and from which it can be removed as desired. This cylinder may be solid; but for lightness it is preferably made hollow. It is of metal, or may be of other solid material. It is journaled in bearings, and is provided with a crank or other means for rotating the same.

Third. In order to support the tablet-holder in the most solid manner, it is provided with a journal at each end, and the journals and bearings are constructed to prevent end motion. It is made detachable from its support at one or both ends, in order to permit the placing and removal of the tablet. It will be understood that any ordinary or suitable means may be used for this purpose; but it is preferred to use the means next to be described.

Fourth. To facilitate the placing of the tablet on the holder and its removal therefrom, and to avoid the removal of the tablet-holder from the machine-frame when this operation is performed, a ball-journal fitting in a cup or socket bearing is employed at one end, (the other end being made detachable from the machine-frame,) so that the holder can readily be tipped up and held in that position while placing or removing the tablet. The ball-journal and socket-bearing prevent end motion of the tablet-holder.

Fifth. With the object of further facilitating the placing and removal of the tablet, the detachable end of the tablet-holder is held down by means of a catch or other device which can readily be released, and a spring is combined with the holder in such a way as to raise the detachable end thereof when the catch is released.

Sixth. The journal at the detachable end of the tablet-holder, instead of resting directly upon the machine-frame, or a bearing attached thereto, is provided with a box or sleeve which fits over the journal and forms the bearing therefor. This box or sleeve remains on the journal when it is detached, and protects it from dirt, as well as prevents the lubricant on the journal from soiling the hands of the person using the machine. The spring for raising the holder acts upon this box, (a rod being interposed,) and the journal is relieved of its pressure. Another advantage which the use of this box or sleeve gives is that if the two bearings in the machine-frame are not precisely in line the box or sleeve may adjust itself properly without jamming the journal. The very slight space which always intervenes when two separate pieces rest in contact will suffice to compensate for the very slight irregularity in alignment which a careful workman would leave.

Seventh. For recording the sonorous vibrations in or on the tablet, and for producing the sounds from the record, the recording or the reproducing instrument (called hereinafter "recorder" and "reproducer," respectively,) is moved lengthwise of the tablet by a screw, which is revolved at a less speed than the tablet. Thus with a comparatively coarse-threaded screw the lines may be traced on the tablet very close together. Heretofore the lines were the same distance apart as the threads of the screw.

Eighth. To enable the recorder and reproducer readily to be applied to and removed from the screw, so that one screw can be used for both instruments, they are each provided with a divided or partial nut, which engages the screw. To prevent the instrument from being disengaged accidentally, a guard is or may be provided which can be slipped under the screw when the instrument is in place, or be withdrawn when it is desired to remove it. Both the reproducer and the recorder may have such a guard; but practically it is more important for the recorder.

Ninth. Instead of having the recorder and reproducer mounted upon a slide moving in ways or guides, and connected with a screw for moving the same, they are mounted on a carrier, which is not only engaged by said screw, but supported by the same, so as to be movable lengthwise of the screw, and capable also of turning on it as on a journal. Thus devices heretofore considered necessary are dispensed with and a movement of the recorder or reproducer toward and away from the tablet is provided for.

Tenth. It is often desirable, especially in reproducing, to stop the operation of the machine temporarily. To enable this to be effected instantly without stopping the main shaft of the machine, mechanism is provided for putting the feed-screw out of action, and at the same time automatically lifting the instrument clear of the record. Heretofore it has been necessary to stop the machine entirely. This is not desirable, because in stopping and restarting the machine a difference in speed, which appears on the record or in the sounds reproduced, is almost certainly made, particularly where a fly-wheel is used to give steadiness of motion.

Eleventh. It is also desirable in reproducing to be able to repeat a word, a sentence, or paragraph. To effect this a reversing as well as a stop mechanism is employed, so that by bringing said mechanism into action the motion of the reproducer is reversed and the instrument is brought back to the beginning of the part to be repeated, being meanwhile lifted clear of the record, which continues or may continue to revolve in the same direction at a uniform speed

Twelfth. In order that the depth of the record may be unaffected by the slight distortions of the recording-surface, (which, it is very difficult to avoid, whether this surface be plane, as in the disk-tablet, or cylindrical, as in the improved form of tablet before indicated,) the recorder is pressed toward the recording-tablet by yielding pressure, (such as that of gravity or a spring,) and is provided with a rest, which bears upon the tablet. The recording-style projects beyond this rest and is connected with a diaphragm or other known or suitable means for impressing sonorous vibrations upon it independently of the rest. By having the recorder maintained always at a given distance from the recording-surface independently of the recording-style, it is possible to cut effectively a shallower record than can be done otherwise, because if the recorder is held stationary the depth of the record must always be greater than the variations in the distance of the recording-surface due to the distortions thereof, and, on the other hand, if the yielding pressure of the recorder is borne by the style it will, if heavy enough for other purposes, press the style to a greater depth than is otherwise necessary. The use of the rest thus relieves the recording-style of pressure, and enables it to be mounted more sensitively and to be made lighter, while at the same time and for a like reason its amplitude of vibration under a given impulse and consequently the strength of the record are increased. The rest could course, be used with any ordinary or suitable mode of mounting the style.

Thirteenth. To regulate the depth of the record the rest is made adjustable lengthwise of the recording-style.

Fourteenth. In order to secure the most sensitive mounting for the recording-style, the latter is made from a short piece of wire and is attached directly to a diaphragm, so as to be carried thereby, the means preferably employed being a screw-thread on the style, a nut of hard rubber engaging the same, and a disk or washer of hard rubber, between which and the nut the diaphragm is clamped.

Fifteenth. A sound conveyer or concentrator is used for the recorder, which concentrator comprises a flaring mouth-piece of elliptical or oval section and a tapering tube forming a continuation thereof. It is found that a mouth-piece which concentrates the sound is desirable to increase the strength of the record, that a mouth-piece which covers the nose is desirable to convey the nasal as well as other vibrations, and that a tapering tube is desirable to amplify and re-enforce the sound-waves. It is found that the longer this tube is, within certain limits, the greater its re-enforcement of the sound; but that a too great length gives a hollow effect, as when words are spoken into an empty barrel. For the sake of lightness it is preferred to make the mouth-piece and tube of thin sheets of hard rubber, or of paper, or the like material. Metal mouth-pieces and tubes have also been used with good effect.

Sixteenth. Where the record is cut in wax the little shavings or chips are apt to cling to the record and have to be brushed off before reproducing. This can be done by hand; but it is not desirable to rely wholly upon hand-brushing, as too much care would have to be exercised to insure that no particles adhere. The record is also liable to collect dust. To avoid difficulty on these accounts without care on the part of the user, the reproducer is provided with a small brush, which bears upon the tablet and sweeps the record in advance of the reproducing-style.

Seventeenth. The record is not always perfectly true or straight—that is to say, the recording-style not only moves lengthwise or at right angles to the recording-surface, but has or is liable to have a side vibration, which of course is recorded in the tablet. These side vibrations produce errors in reproducing unless means are provided for enabling the reproducing-style to move sidewise also. The mounting of the reproducer on a universal joint obviates the difficulty to a certain extent, but not altogether satisfactorily, since the inertia due to the large mass of the reproducer is too great for it to respond as quickly as required. The difficulty is in the present invention overcome much more thoroughly by supporting the reproducing-style so that it, or at least the end in contact with the record, can move sidewise independently of the diaphragm or other device upon which it impresses the vibrations. This freedom to move sidewise can be secured by allowing the style to rock upon the end in contact with the diaphragm or other device behind, or by making the style in whole or in part of flexible material, or by mounting it on a flexible support, the flexibility of course being in the required direction.

Eighteenth. In order to allow the reproducing-style the greatest freedom of side movement, while insuring its return to a central position, and without impairing to a serious extent its rigidity in other directions, a comparatively broad and thin strip of spring metal, placed on edge is connected with or forms part of the reproducing-style. Such a strip is very flexible to side pressures, but comparatively rigid to other pressures. The strip is fastened to the diaphragm, or to the device upon which it is desired to impress the vibrations, or it is otherwise hinged so that it can impress vibrations on said device; or said strip may be rigidly connected with the frame of the reproducer and the style be flexibly connected with the outer end of the strip. Preferably the reproducing-style is fastened to the end of a thin metal strip parallel with the width thereof, so as to form a hammer-like arrangement, the style being the hammer-head. It is a pin or wire several times as thick as the metal strip. The vibrations are transmitted through the hammer-head, the metal strip being attached to a spring, or it may be otherwise hinged to the frame of the reproducer.

Nineteenth. In transmitting the vibrations to the diaphragm it is found that with a rigid connection between the record and the diaphragm pronounced foreign vibrations are impressed upon the diaphragm or its substitute, producing scratching noises. These foreign noises can be lessened without diminishing the reproduced speech to the same extent by the interposition of a flat metal spring in such a way that while serving as the means of communicating vibrations to the diaphragm it can be bent independently. It is probable that this spring absorbs the vibrations which produce the scratching noises to the greatest extent, because they are more minute and rapid than speech-vibrations. Heretofore a section of rubber tubing has been interposed between the style and diaphragm; but it cannot be made as delicate as a metal spring, and for other reasons, also, is not so advantageous. For example, it is believed that it does not transmit the true vibrations of the record with as much clearness, the rubber loses its elasticity after a short time, and the tubular form of spring is less compact and less easily secured in place.

Twentieth. Another difficulty in reproducing is the passage of the style from one elevation of the record to the next without descending to the bottom of the space between. This causes a rattling sound, and sometimes makes the reproduction unintelligible. It is overcome to a useful extent, if not entirely, by combining with the style a quick-returning spring, by which the style will be pressed to the bottom of the record in the short space between two elevations. This spring should be of quicker return than the diaphragm. It is evident that the same spring may perform this function and also that of absorbing the foreign vibrations.

Twenty-first. The diaphragm is pressed against a concave seat whose walls converge like the walls of a cone, or of a section of a sphere, ellipsoid, paraboloid, or the like toward an opening through which the sound can escape. Thus a space of the general shape of a plano-convex lens, or, taking into consideration the slight convexity of the inner side of the diaphragm of a concavo-convex lens, is formed behind the diaphragm. This form of space is found to convey the sounds better than the flat space, such as customary in speaking-telephone receivers as well as in the ordinary phonograph. This concave seat for the diaphragm is also advantageous, as it makes the latter self-centering. A spring bearing upon the diaphragm holds it in place and also strains it. This spring may or may not be employed for absorbing the foreign vibrations, or for giving a quick return to the style, or for both. The arrangement preferably employed is to have a light flat spring project above the diaphragm, a block (say of cork) being interposed between the spring and the diaphragm and the style pressing against the end of the spring a short distance beyond the block. The block may be secured in the most effective position or it may be left unfastened, so that it can be adjusted lengthwise of the spring to increase or diminish the part projecting beyond the block or to bring it directly under the style. In this last position the loudest reproduction is obtained, but the scratching and rattling noises are also the most pronounced.

Twenty-second. The diaphragm is preferably made of hard rubber, this material having been found to give out purer sounds, the minute foreign vibrations being absorbed to a greater extent than with mica or metal, either of which and other materials also can be used with intelligible results.

Twenty-third. To protect the style from accidental injury, it is protected by a guard, beyond which only the rubbing end or point of the style projects. As a further protection, the guard is curved outward on either side of the style, forming horns, which, if the reproducer be placed face down on a table, sustain the weight instead of allowing it to come on the style. The particular form of guard is of course only suitable for use with a cylindrical record, which can enter between the horns to make contact with the style.

Twenty-fourth. The sounds from the reproducer can be conveyed to the ear in various ways; but preferably the space behind the diaphragm or other vibratory body is connected by a sound-conveying tube with a double ear-piece somewhat similar to a stethoscope. It consist of two elastic and flexible hollow branches provided each with a cup fastened to the branch by a ball-and-socket joint. The cups fit over the ears and are held against the head by the elasticity of the branches, the universal joint allowing each cup to adjust itself to the head of the user.

Twenty-fifth. It is found desirable in reproducing to modify the loudness of the reproduced sounds according to the sensitiveness of the ear of the listener. This effect can be produced by the adjustment of the block between the spring and the diaphragm mentioned above under the twenty-first head; but it is not always convenient or advantageous to produce it in that way—as, for example, if two persons are listening to the instrument at the same time. To accomplish the desired object, a stop-cock is placed in the sound-conveying tube between the reproducer-diaphragm and the ear, so that by partially closing the same more or less of the sounds can be cut off, as desired. Where more than one person is listening, each of the sound-conveyers may have its own stop-cock.

Twenty-sixth. When a device such as just described is used, or when any device is used which is to be held by the user, or to be placed close to his ear, there is always a liability of the user pulling upon or jarring the reproducer, and if this is not firmly secured of pulling it from the machine. To overcome this difficulty without interfering with the traverse of the reproducer in front of the record, a flexible connection adapted to convey sound, and at the same time not restrict the traverse of the reproducer, is provided between the reproducer and a tube or tubular coupling attached to the machine-frame. The ear-tube or other device is connected with this tube or coupling, so that any pull or thrust comes upon the solid machine-frame, and will or may detach the ear-tube rather than damage the machine.

Twenty-seventh. In placing the reproducer on the screw it is desirable to hold the style away from the record until the reproducer is in place on the screw, and in removing it to lift the style from the record before attempting to remove the reproducer. The object is to prevent injury to the record. To effect the desired result the standard of the reproducer is hinged to its base or carrier, and is provided with a tail or thumb piece, or some equivalent device, so that in grasping the base or carrier the thumb or other part of the hand pressing upon said tail will hold the reproducer away from the record. Upon release of the tail the reproducer rests by its weight (which is preferably made very small) upon the record.

The invention further comprises certain special constructions, combinations, and arrangements of parts, as hereinafter set forth, among which are included the combination, in one machine, of the several improvements already indicated, or of two or more of them.

Having explained the principle of the invention, a description will now be given of what is considered the best mode of applying the same, reference being had to the accompanying drawings, which form a part of this specification

Figure 1 is a plan view of a machine or phonograph constructed in accordance with the invention, the reproducer being shown in place and the recorder omitted; Fig. 2, a vertical cross-section in elevation, looking to the right in Fig. 1; Fig. 3, a section in the plane of Fig. 2, but in elevation, looking to the left, the recorder being shown in place and its mouth-piece being broken away; Fig. 4, a view similar to Fig. 3, but with the reproducer in place instead of the recorder; Fig. 5, a partial vertical longitudinal section on line *x x* of Fig. 2; Fig. 6, an elevation, partly in section, of a part of the left end of the machine. Fig. 7 is an elevation, partly in section, of the recorder, its carrier, and sound-concentrator; Fig. 8, a top view (on a reduced scale) of the sound-concentrator of the recorder; Fig. 9, a central section of the recorder in a plane at right angles to those of Figs. 3 and 7, showing the base or carrier in elevation, and Fig. 10 a section through the base or carrier of the recorder. Fig. 11 is a central vertical section of the reproducer, its carrier, and certain accessory parts; Fig. 12, a face view of the reproducer; Fig. 13, a perspective detail view; Fig. 14, a section through the base or carrier of the instrument; Fig. 15, a section illustrating a modified form of style; Fig. 16, an elevation, partly in section, (on a reduced scale,) of a listening device with double ear-pieces; and Fig. 17 a section illustrating a third modification of the reproducer.

The frame of the machine, as shown, consists of two upright side pieces, 300 and 301, connected by tie-rods 302 and 303 and the tube 304, which serves as a tie-rod. The tablet-holder 305, in the form of an elongated metal cylinder, is journaled in bearings at the top of the side pieces. The right journal, 306, is ballshaped and rests in a socket, (see Fig. 5,) which permits the tablet-holder to be tilted up, as indicated in dotted lines, as well as to be revolved, while endwise motion is effectually prevented. The fly-wheel 317, provided with a crank-handle, is mounted on a prolongation of the journal and serves to revolve the tablet-holder. The left journal, 307, which is or may be cylindrical, fits and revolves within a box, 308, which is held in place on the journal by a screw, 309, in the end thereof. The box 308 is confined between a seat on the side piece, 301, and the hinged cap 310, which is held down by the spring-catch 311, (see Fig. 6,) fastened at the bottom in the plug 312, which is adjustably retained in position by the set-screw 313. The catch can be released at will by a push-pin, 314. Below the journal 307 is a follower, 315, fitting into and movable in a hole in side piece, 301, acted upon by the spiral compression-spring 316, placed below it in the hole. The box 308 rests upon the top of the follower and relieves the journal of all pressure from the spring 316 when the cap 310 is held down by the catch 311. This pressure prevents the box turning. On releasing the catch 311 the spring 316 expands and throws up the journal 307 and the cap 310, as shown in Fig. 6. The cap can then be turned back and the tablet-holder be tipped up and held in an inclined position by a hand on the fly-wheel 317. The tablet consists of an elongated hollow cylinder or tube, 318, of paper or pasteboard—say one-fortieth of an inch in thickness—coated with a layer about one-thirtieth ($\frac{1}{30}$) of an inch in thickness of a compound of one part, by weight, of white beeswax and two parts of paraffine. The beeswax and paraffine should be melted and stirred together, and then filtered, unless they are entirely free from sticks, dirt, and other foreign particles. The coating is or may be applied by stopping the ends of the cylinder, partly immersing it in a bath of the melted composition and turning it therein one or more times, removing it and allowing the material to harden, keeping it in motion meanwhile to prevent running, then immersing and rotating it again, and allowing the adherent layer to harden, and so continuing until a coating of rather more than the thickness above indicated is attained. The surface is then turned smooth in a lathe, being supported on a cylinder like the tablet-holder 305. The tablet is then ready for use by placing over the holder, or it may be kept until wanted. In keeping care should be taken to prevent access of dust. After the tablet has been placed on the holder the detachable end of the latter is pressed down into its bearing, and the cap 310 is engaged by the catch 311, which holds it down.

The record is made on or in the wax coating of the tablet by the instrument shown in Figs. 3 and 7 to 10. The diaphragm 320 (of mica, from six to twelve one-thousandths ($\frac{6}{1000}$ to $\frac{12}{1000}$) of an inch in thickness) is held in a frame, 321, between the flange 322 and a ring, 323, of soft rubber tubing, which is held down by the back plate 324, and screws 325, tapped into the frame. The heads of these screws project over the edge of the back plate. The recording-style 326, formed of a steel wire (say, one-thirty-second of an inch in diameter) sharpened at the front or operating end, like an ordinary round-pointed turning tool and screw threaded at the other, is fastened to the center of the diaphragm by the nut 327 and washer 328, which are on opposite sides of the diaphragm, and clamp it between them. The cutting-edge of the style is preferably shaped to cut a groove of curved rather than of V-shaped cross-section. A bar, 329, is hinged at one end to the frame 321 by a pivot screw-pin, 385, and at the other adjustably but rigidly fastened thereto by a screw, 330. A second screw, 331, bearing at the point against the top of the bar 329, assists in securing an exact adjustment and in holding the bar rigid. At the middle of the bar is an enlargement, 332, which extends into close proximity to the recording-style (see Fig. 9) and whose bottom is polished or made smooth, so that it may bear upon the wax-coated tablet and move over it without injury to the wax surface. The frame 321 is provided with a base or carrier, 333, in the form of a half-nut. In use this nut is supported and engaged by the rotatory feed-screw 334, which is journaled in bearings in the side pieces, 300 and 301. The base or carrier is elongated to give a sufficient bearing on the screw to prevent the tipping of the recorder sidewise. To assist in preventing this, and also to prevent the carrier being lifted from the screw, a guard is provided, which consists of a block, 335, attached to the end of a curved slide, 336. This slide is guided by the piece 337, and can be turned from the position shown in Fig. 7 when the guard does not interfere with the placing of the carrier on the screw into the position shown in Figs. 3 and 10, when it prevents the removal. The carrier is, however, free to turn on the screw, as on an axle, so that the recorder, under the action of gravity, will press against the tablet, the bar 329 forming a rest to support it. The recording-style projects beyond the rest and enters the wax coating, penetrating it a distance which is regulated by the adjustment of said rest or bar 329. The sound-conveyer consists of an elliptical mouth-piece, 338, and a tapering tube, 339, both made, for lightness, of hard rubber, in thin sheets—say one-thirty-second ($\frac{1}{32}$) of an inch thick. A metal thimble, 340, is attached to the small end of the tapering tube, which fits over a tubular projection, 341, on the back plate. The rotation of the feed-screw 334 moves the recorder lengthwise of the recording-tablet, and this movement, in connection with the rotation of the tablet, causes the style to trace a spiral line in the wax, which line becomes a sound-record by talking into the mouth-piece 338, and thereby impressing sonorous vibrations upon the diaphragm and style. The style then cuts a variable line, whose irregularities or inequalities correspond to the sound to be recorded. The spiral line can be omitted for a given distance, when desired, by simply lifting the recorder from the tablet. The feed-screw 334 should be so mounted as to prevent endwise movement, which would tend to make the traced line more or less zigzag. As shown, a spring, 342, (see Figs. 1 and 6,) presses constantly upon the left end of the screw to keep it against the bearing at the opposite end. The feed-screw is revolved by the friction-wheels. (Shown in Figs. 1, 2, and 5.) In recording, the friction-pinion 343 on the tablet-holder communicates motion to the large wheel 344, fast on the feed-screw, through the intermediate 345. Thus the feed-screw has a much slower rotation than the tablet-holder, and the convolutions of the line traced on the tablet are much closer together than the threads of the feed-screw. The intermediate 345 is mounted on the stud 346, (see Fig. 5,) which is carried by a hinged frame, so that the intermediate can be moved out of contact with the pinion whenever it is desired to stop the feed, without interrupting the rotation of the tablet-holder. The hinged frame consists of side bars, 347, which are hinged separably on the tie-rod 302, and are rigidly connected with each other by tie-bars 348 and 349. A spring, 350, under each side bar tends to lift the frame and press the intermediate 345 against the pinion 343. The feed-screw is therefore normally in engagement with the tablet-holder; but can be disengaged at will by pressing upon the tie-bar 348. The friction-wheels 351 and 352 are for reversing the revolution of the feed-screw. The wheel or pinion 352 is simply a hub on the side of the intermediate 345. The wheel 351 presses against the pinion 352, and is mounted on a stud at the end of bent lever 353, which turns upon the screw-stud 354 in line with the stud 346. (See Fig. 5.) The lever 353 thus turns about the axis of the wheel 352, and the wheel 351 may roll over the surface of the wheel 352, so as to be pressed against and thus engage the pinion 343 on the tablet-holder. The short arm of the bent lever is connected by a link, 355, with the stud 356, itself secured fast to the side piece, 300. When, therefore, the tie-bar 348 and side bars, 347, are depressed, the lever, as shown in Fig. 2, is turned to the left, and when it is sufficiently depressed the wheel 351 is held against and engaged by the pinion 343. Motion is now communicated through the wheels 343, 351, 352, 345, and 344, the rotation of the feed-screw is reversed, and a more rapid rotation is imparted to it. The carrier will therefore be moved backward (to the left in Fig. 1) more rapidly than it was advanced. There will ordinarily be not much occasion to use the stop and reversing mechanism in recording. It is for use in reproducing that it has been specially devised. The reproducer (see Figs. 1, 4, 11, 12, and 13) has a style, 357, welded or otherwise fastened to the end of a flexible strip, 358, of thin steel—say three one-thousandths $(\frac{3}{1000})$ of an inch in thickness—so as to project beyond both edges of the same like a hammer-head. The outer end of this style (which should be somewhat more tapering at the point than the recording-style) rubs over the record or tablet. The inner end presses upon a light flat spring, 359, fastened at the lower end to the frame 360 of the reproducer. The strip 358 is soldered into a slit of the ear 361, on the spring, which by bending between the ear 361, and where it is attached to the frame 360 allows the style and strip to be moved in or out, and thus serves to hinge the same to the said frame. The diaphragm 362, of hard rubber about seven one-thousandths $(\frac{7}{1000})$ of an inch in thickness, is pressed against a conical seat in the face of the frame 360 by means of the spring 359, between which and said diaphragm is a little block, 363, of cork. It serves the double function of pressing the diaphragm against its seat, and also of communicating vibrations to it. Cork is used because it is light and conveys vibrations well and has sufficient friction upon the diaphragm and spring to remain in the position in which it may be placed. By leaving it to be held by friction it can be adjusted by the user to give the best effects; but it can be secured by cement or otherwise in the position which the maker or adjuster of the instrument may determine. Preferably it occupies a position intermediate the style 357 and the edge of the diaphragm, as shown; but it can be set directly opposite the style. In the former position there is a certain length of the spring 359 beyond the cork, which length forms a tongue with a very high rate of normal vibration. It absorbs a considerable portion of the small vibrations which produce scratching noises, and it thus makes the articulation more distinct. It also reduces somewhat the loudness of the sounds reproduced, but the increased distinctness more than compensates for any loss in loudness.

Another effect which the tongue has is to return the style more perfectly when it has been pushed out by an elevation on the record. It does this because its normal vibration is quicker than that of the diaphragm or because its amplitude of vibration is larger, or for both reasons. It will be understood that this spring-tongue is compressed by the weight of the reproducer, which is sustained by the style. This weight is actually very small, the frame being made, for lightness, of hard rubber, but in comparison with the strength of the spring-tongue it is considerable. It will be observed that the diaphragm is strained by the spring in addition to the strain due to the weight of the reproducer. The inner end of the style 357 preferably rests in a hole or recess in the spring 359, so that it is prevented from side motion bodily, although capable of rocking on the inner end as a center. The bending of the strip 358 allows this side movement of the front end of the style to take place with the greatest freedom. A bodily movement of the style sidewise could be permitted, if desired, but a stop should then be used to prevent it from being pushed off the spring 359.

To protect the style and other parts of the reproducer, a guard, 364, is fastened to the front of frame 360, and is perforated at the center for the passage of the style. On either side of the center it is bent outward to form horns to support the instrument when placed face downward on a table or flat surface.

The reproducer, consisting of the parts just described, is mounted upon a hollow standard, 365, which is hinged at the bottom to the carrier 366 by means of hollow trunnions 367, fitting in hollow uprights 368 on said carrier. The reproducer-standard 365 is provided with a thumb-piece, 369, which can be pressed to hold up the reproducer in placing the carrier on and removing it from the feed-screw 334. There are front and back screw-stops, 370 and 371, which limit the movement of the reproducer independently of the carrier. This latter is provided with a half-nut to rest upon and engage the feed-screw, the same as the carrier of the recorder. It is not provided with a guard to retain it on the feed-screw because it is considered unnecessary, particularly when a flexible sound-conveyer is employed, as will presently be described. It is provided with a tail or prolongation, 372, which rests upon the tie-bar 348, (see Fig. 4,) so that when this is depressed to stop or to reverse the feed-screw the carrier will turn to the left (the center of gravity being on that side of the feed-screw) and automatically lift the reproducing-style 357 from contact with the tablet 318, in or on which the record is formed. When the tie-bar 348 is released, the springs 350 raise it and turn the reproducer and its carrier to the right, so that the style again makes contact with the record. It will be observed that the pressure of the springs 350 does not force the style against the record. because the reproducer is hinged to its carrier and only its very light weight comes upon the reproducing-style and the record. On the carrier is a brush, 373, which, when the producer is in action, bears upon the record and clears it of dust or shavings of wax or other lightly-adhering matter in advance of the reproducing-style.

The hollow standard 365 serves to convey sound from the lenticular chamber behind the diaphragm into the uprights 368, with the interior of which the coupling 374 communicates. To this coupling a flexible sound-conveyer, 375, is attached at one end, the other end being connected with an upright branch of the tube 304. Thus the sound is conveyed from the interior of the uprights 368 through the coupling 374 and sound-conveyer 375 and tube 304, the flexibility of said conveyer 375 permitting the traverse of the reproducer, as well as the turning of the carrier 366 on the feed-screw 334. The tube 304 communicates with tubes 376 and 377, one at each end of the machine. A hearing-tube is or may be attached to either or both tubes. Preferably the apparatus shown in Fig. 16 is employed It consists of two elastic and flexible hollow branches, 378, each provided at the outer end with a cup, 379, attached by a ball-and-socket joint, and a flexible sound-conveying tube, 380, for connecting both branches with the tube 376 or 377. As shown, there is a hollow metal coupling, 381, at the free end of the flexible tube 380, of such exterior diameter as to fit snugly in the tube which is to receive it. (See Fig. 4.) This coupling is provided with a stop-cock, 387, which can be turned to cut off more or less sound if the reproduction be too loud. This diminution in loudness makes the scratching noises less distracting to a person with a sensitive ear.

In use the cups 379 are placed one over each ear of the listener, the ball-and-socket joint permitting the cup to adjust itself to his head, and the elasticity of the branches 378 drawing them with sufficient pressure to support the apparatus.

The branches may be made of hard vulcanized rubber, in order to secure the requisite flexibility and elasticity; but it is evident that sound-conveying branches having these qualities could be constructed of various materials and in various ways

Instead of applying the tube 380 to the tube 376 or 377, it may be connected directly with the coupling 374, the sound-conveyer 375 being omitted. This has the advantage of diminishing the length of tube between the reproducer and the ear of the listener, but is open to the objection that the reproducer is liable to be pulled from the machine by incautious movements on the part of the listener.

It may be observed that the reproduced sound may be listened to in various ways, and that it is possible to perceive the sounds by applying the ear close to the reproducer itself.

In the modified form of reproducer shown in Fig. 15 the style 382 is made of a thin plate of sheet-steel—say three one-thousandths of an inch in thickness—of the form clearly shown, fastened on edge on the spring 359, being soldered in a slit in the ear 383, and a similar slit in the end of the metal buttons 384, which end projects through the spring 359. This button bears upon the hard-rubber diaphragm 362, and serves to communicate vibrations from the style to it.

In the form of reproducer shown in Fig. 17 the style 390 is interposed between the diaphragm 362 and the flat spring 391. Near each end the style has a rounded shoulder, and the ends themselves are of smaller diameter, so that they may pass through holes in the diaphragm and spring, as shown, the latter pressing upon the shoulders. The spring 391, whose flat side is toward the diaphragm, is attached to the strip 392, which is soldered or otherwise fastened to the post 393. The spring

391 retains the outer or operating end of the style in place while allowing it freedom to move endwise for impressing vibrations upon the diaphragm. Preferably it exerts a light pressure inward, tending to strain the diaphragm, as well as maintain itself in contact with the shoulder on the style. It supplies the place of spring 359 of Figs. 11 and 15. The strip 392, whose edge is turned toward the diaphragm, allows the operating end of the style to move sidewise. It thus supplies the place of strip 358 of Fig. 11, and that which forms the style 383 of Fig. 15.

The construction of Fig. 17 has the advantage over the other forms that there is less material to be moved by the vibrations of the style.

The parts 391 and 392 can most conveniently be made from a round wire by filing the same flat at proper points.

The operation of the machine has practically been explained in the foregoing description in connection with the several parts of the machine, but an explanation will now be given of the operation as a whole. Having prepared a hollow paper cylinder and coated it with the paraffine and beeswax composition, the coated cylinder 318 (which forms the recording-tablet) is placed upon the tablet-holder 305, which for that purpose is detached at one end by releasing the catch 311, and tipped up, as indicated in dotted lines in Fig. 5. The detached end of the tablet-holder is then returned to its bearings in side piece, 301. Having adjusted the rest 329 of the recorder so that the recording-style 326 projects beyond the enlargement 332 the desired distance—say five one-thousandths ($\frac{5}{1000}$) of an inch—the recorder-carrier 333 is placed on the feed-screw 334, near the left end of the same, the guard-block 335 is turned under the screw, and the recorder is made to rest against the recording-tablet, the weight being supported by the rest 329, and the style 326 penetrating the wax coating. The fly-wheel 317 is then turned, revolving the tablet-holder and tablet, and also, but at a less speed, the feed-screw 334. Since the recorder is moved lengthwise of the tablet as the latter is revolved under it, the recording-style traces, or more specifically cuts, in the wax coating a spiral groove whose convolutions are closer together than the threads of the feed-screw. The convolutions may be eight one-thousandths ($\frac{8}{1000}$) of an inch apart. To make a speech record in or on the tablet, the speaker places the lower part of his face in the mouth-piece 338 and says in a clear and moderately loud voice the words to be recorded, the fly-wheel being kept in motion at a uniform speed of say one hundred and sixty revolutions per minute. If it be desired to mark visibly a paragraph on the record, it can be done by lifting the recorder for a short time from the record, then releasing it, and again speaking into the mouthpiece. The sonorous vibrations which the speaker impresses upon the air in the mouthpiece 338 and tube 339 are taken up by the diaphragm 320 and style 326, and the latter cuts a groove in the tablet, which is correspondingly irregular. After the record has been cut over the whole tablet, or over as much as may be desired, the recorder is removed. The tablet is also removed and brushed to remove the wax shavings, and then, or at some future time, is replaced on the tablet-holder of the same or of a similar machine. The reproducer-carrier 366 is placed on the feed-screw 334, the tail 372 resting on the tie-bar 348. The thumb-piece 369 of the reproducer-standard is pressed upon to keep the style 357 or 382 from contact with the record until the carrier has been placed on the screw. It is then released, and the reproducer, falling forward, brings the style into contact with the record. Preferably the grooves are so close together that the ridge between them tapers to an edge on top, so that no matter where the reproducer may be placed the style will enter a groove, and being free to move sidewise will, owing to the sloping sides of the groove, penetrate to the bottom thereof under the action of gravity. The fly wheel being turned at about the speed used in recording, the reproducer will follow the spiral groove cut by the recorder, and will be acted upon by the inequalities or irregularities of the record, and made to reproduce sounds or sonorous vibrations similar to those which acted upon the recorder to produce said inequalities or irregularities in the groove. Each elevation as it passes under the style at first presses the latter outward, and, when the top of the elevation is reached, allows it to be returned inward by the tension of the diaphragm and spring, or of the diaphragm alone. By these alternating movements, repeated for each ascent and descent in the record, and corresponding in extent and rapidity with the length and slope of the ascent and descent, the diaphragm is thrown into vibrations corresponding in form to the sonorous vibrations which caused the irregularities or inequalities. In addition to these vibrations, foreign vibrations, due to various causes, are also impressed upon the diaphragm. These should be disregarded, as far as possible, by the listener confining his attention to the speech-vibrations. They will (in the reproducer shown in Figs. 11 and 13) be measurably taken up by the vibration independently of the diaphragm 362 of the tongue formed by the end of the spring 359, which projects beyond the block 363.

In certain speech-sounds it is found that the diaphragm responds too sluggishly, and that in consequence of this sluggishness the style, if influenced by the diaphragm alone, will not descend to the bottom of a depression in the groove, but will skip across, thus cutting off more or less of the vibration. The tongue of the spring 359 responds more readily than the diaphragm and diminishes the danger of false vibrations. This spring-tongue also absorbs a portion of the speech-vibrations, thus diminishing the loudness of the reproduced sound; but any loss in this respect will be more than balanced by the improvement in distinctness. The vibrations of the diaphragm being impressed upon the air in the chamber behind the same are conveyed through the standard 365, the uprights 368, the coupling 374, the flexible tube 375, the tube 304, the tube 376 or 377, the tube 380, and the branches 378 to the ears of the listener. Should it be desired to interrupt the reproduction for a time, the tie-bar 348 is pressed lightly, thereby withdrawing the intermediate 345 from contact with the pinion 343 and stopping the rotation of the feed-screw 334. At the same time the reproducer-carrier 366 is allowed by the depression of the tie-bar to turn sufficiently to lift the reproducer-style 357 clear of the record, the front stop, 370, coming in contact with the standard 365 and raising the same. Should one or more words, phrases, or sentences not be understood, the tie-bar 348 is pressed more strongly, so as to bring the wheel 351 into engagement with the pinion 343, and thereby reverse the rotation of the feed-screw. When the reproducer has been carried back beyond the part of the record from which the reproduction was not understood, the tie-bar 348 is released, the style again comes into contact with the record, and the reproduction commences at the point to which the reproducer has been brought back. This repetition of what is not understood can be made as often as desired.

Friction-wheels for communicating motion to the feed-screw are preferred to cog or other toothed gearing, (which could of course be used without departing from the invention,) notwithstanding their liability to slip, because they run smoother and are more easily engaged and disengaged. A slip between the wheels causes the reproducer to be fed faster or slower than the spiral on the tablet permits the style to advance. As a general thing, there is more slip in recording than in reproducing, and consequently the reproducer outruns the style slightly. The style should be given enough side play to compensate for this difference in speed; but if not given the only difficulty is that the style will at length slip across the ridge between the grooves, and thus escape the action of a portion of the record, so that it may be necessary to bring back the reproducer by reversing the feed. The loudness of the reproduction is limited as desired by turning the stop-cock 387 to the desired extent.

In the foregoing description of the machine shown in the drawings, dimensions, proportions, materials, and other details of construction are mentioned with particularity for the purpose of enabling others more readily to make and use the new improvements, and not as limitations of the said improvements, since it is obvious that modifications can be made in details without departing from the spirit of the invention, and that parts of the invention can be used separately.

The terms "recorder" and "reproducer" as used herein include simply means (a style, for example) for acting upon a tablet to form a sound-record, or being acted upon by a sound-record, in connection with means whereby sonorous vibrations can be impressed upon the recording-style or its substitute, or can be received from the reproducing-style or its substitute, and such frame or support as may be necessary to an operative device. As hereinafter employed, they mean a recorder or reproducer of any ordinary or suitable description unless a special form is mentioned, or is necessarily implied from the connection in which the recorder or reproducer is used. For example, some forms of recorder and reproducer would not be suitable for use with a wax-coated tablet. In like manner other terms—such as "tablet," "tablet-holder," "carrier," "sound-conveyer," "gearing," &c.—refer to devices of any ordinary or suitable description, except as otherwise indicated.

The present invention is to be considered as an improvement upon or modification of what is shown and described in the application for Letters Patent of C. A. Bell and myself, filed June 27, 1885, and officially numbered 170,044, so far as they relate to common features, and no claim is made herein to any matter described and shown in that application.

Having now fully described my said invention and the manner in which the same is or may be carried into effect, what I claim is—

1. A recording-tablet for a phonograph, consisting of a hollow cylinder provided with a wax or wax-like coating for receiving the sound-record, substantially as described.

2. A recording-tablet consisting of a hollow cylinder of paper provided with a wax or wax-like coating, substantially as described.

3. The recording-tablet consisting of a hollow paper cylinder coated with a composition of beeswax and paraffine, substantially as described.

4. A tubular self-sustaining tablet for recording sounds or sonorous vibrations, substantially as described.

5. In a phonograph and in combination with a sound recorder or reproducer and operating mechanism for causing the said recorder or reproducer to trace a spiral line on the tablet, an elongated cylindrical tablet-holder supported and journaled so that the tubular tablet can be placed on the same, substantially as described.

6. The combination, with a tubular tablet, of the tablet-holder for supporting and rotating the same, substantially as described.

7. A tablet-holder journaled in bearings at both ends and detachable from its support at least at one end, so that a tubular tablet can be slipped over the same, in combination with a sound-recorder or reproducer, and operating mechanism for causing the said recorder or reproducer to trace a spiral line on the tablet, substantially as described.

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8. A tablet-holder detachably connected with its support at one end and provided at the other end with a ball-and-socket bearing, or bearing which permits the said holder to be tilted for placing a tubular tablet on the same, in combination with a sound recorder or reproducer and operating mechanism for causing said recorder or reproducer to trace a spiral line on the tablet, substantially as described.

9. The combination, with the tablet-holder, the side piece or support at one end of the same, and the cap therefor, of the catch or fastening for said cap and the spring for moving the tablet-holder when the catch is released, substantially as described

10. The combination, with the tablet-holder and the ball-and-socket bearing or bearing for permitting the holder to be tilted, of the support and cap at the opposite end of said holder, the catch or fastening for said cap, and the spring lifting the journal from said support when the catch or fastening is released, substantially as described

11. The combination, with the tablet-holder, of the box or sleeve on one journal of the same, the support and cap forming the bearing for said box or sleeve, and the catch or fastening for the cap, substantially as described.

12. The combination, with the tablet-holder, of the box or sleeve held on one journal of the same, the support and cap forming a bearing for said box or sleeve, and the spring whose pressure acts against said box or sleeve, substantially as described.

13. The combination, with the tablet-holder, of the ball-journal and socket-bearing at one end of said holder, the box or sleeve on the journal at the opposite end of said holder, and the bearing for the same, substantially as described.

14. The combination, with the tablet-holder, the sound-recorder, and the feed-screw, of gearing between said holder and feed-screw for revolving the latter at a slower speed than the former, substantially as described.

15. The combination, with the tablet-holder, sound recorder or reproducer, feed-screw, and gearing for revolving the screw, of the carrier for the recorder or reproducer provided with a divided or partial nut for engaging said screw, substantially as described.

16. The combination, with the feed-screw and the carrier for engaging the same, of the movable guard for retaining the carrier in engagement with the screw, substantially as described.

17. The combination, with a feed-screw and a sound recorder or reproducer, of the carrier for the sound recorder or reproducer engaged and also supported by said screw, substantially as described.

18. The combination, with a feed-screw and a sound recorder or reproducer, of the carrier for the recorder or reproducer movable lengthwise of and engaged by said screw and capable of turning on the same as on a journal, substantially as described.

19. The combination, with a tablet and a tablet-holder, of the feed-screw, a carrier mounted on said screw, and the recorder supported on said carrier and resting against the tablet, substantially as described.

20. The combination, with the tablet-holder, feed-screw, and gearing between the same, of the hinged frame upheld by spring-pressure and the devices connected therewith for putting the feed-screw out of action when the said frame is depressed, substantially as described.

21. The combination, with a tablet-holder, feed-screw, and gearing between the two, of the hinged frame upheld by spring-pressure and reversing mechanism connected with said frame for reversing the rotation of the feed-screw relatively to the rotation of the tablet-holder, substantially as described.

22. The combination, with a tablet-holder, a feed-screw, gearing, and an instrument—the reproducer, for example—engaged by said screw, of stop mechanism for putting the feed-screw out of action and at the same time lifting the instrument clear of the tablet, substantially as described.

23. The combination, with a tablet, a tablet-holder, a feed-screw, gearing, and an instrument—the reproducer, for example—engaged by said screw, of reversing mechanism for reversing the rotation of the feed-screw, the said mechanism being connected with said instrument, so that the latter will be lifted clear of the tablet on the reversal of the feed-screw, substantially as described.

24. The combination, with the tablet and the recorder held against the same by yielding pressure, of a rest bearing on said tablet for supporting the recorder, substantially as described.

25. The combination, with the recorder frame and style and the means whereby sonorous vibrations are impressed upon the style, of the rest attached to said frame and arranged close to said style, the latter projecting beyond the rest to act upon the recording-tablet, substantially as described.

26. The combination, with the recorder, of the adjustable rest attached to said recorder for bearing upon the recording-tablet, substantially as described.

27. The combination, with the recording-style, the recorder-frame, and the means whereby vibrations are impressed upon the style, of the rest attached to said frame and adjustable lengthwise of said style, substantially as described.

28. The combination, with the recorder-frame and the rest attached thereto, of the diaphragm and the recording-style mounted directly on said diaphragm, substantially as described.

29. The combination, with the diaphragm, of the cutting-style formed of a wire sharpened at its outer end and carried by said dia-

phragm so as to vibrate with the same, substantially as described.

30. The combination, with the diaphragm, of the cutting-style provided with a screw-threaded shank, and the nut and washer for securing the same to the diaphragm, substantially as described.

31. The combination, with a recorder having a cutting-style, of the rest for bearing upon the recording-tablet, substantially as described.

32. The combination, with the tablet having a wax or wax-like coating to receive the record, of the recorder pressed toward the tablet by yielding pressure and provided with a cutting-style and the rest for bearing upon the tablet and supporting said pressure, substantially as described.

33. The combination, with the recorder, of the sound-concentrator comprising a flaring mouth-piece and a tapering tube forming a continuation of the same, substantially as described.

34. The combination, with the recorder, of the sound-concentrator comprising a mouth-piece of elliptical form and a tapering tube forming a continuation of the same, substantially as described.

35. The combination, with the reproducer, of the brush for clearing the record in advance of the reproducer, substantially as described.

36. The combination, with the recording-tablet having a wax or wax-like coating in which the record is cut, of the reproducer and the brush for clearing the record in advance of the reproducer, substantially as described.

37. A recording-tablet consisting of a hollow cylinder provided with a wax or wax-like coating and having a sound-record cut in said coating, substantially as described.

38. The combination, with the tablet and tablet-holder, of the feed-screw, the gearing, the reproducer-carrier, and the brush, substantially as described.

39. A reproducer having a flexible or flexibly-mounted style movable sidewise independently of the diaphragm or device to which the style communicates vibration, substantially as described.

40. A reproducer having the style attached to or in one piece with a comparatively broad and thin strip placed on edge, said style in consequence of the flexibility of said strip being movable sidewise independently of the diaphragm or device to which the style communicates vibration, but in consequence of the breadth of said strip being practically rigid to pressures in other directions, substantially as described.

41. The combination, with the reproducer-style and diaphragm or device to which said style is to communicate vibrations, of a comparatively broad and thin strip placed on edge and attached to or in one piece with said style, said strip being hinged to the frame, so that the style may be vibrated in the plane of said strip, substantially as described.

42. In a reproducer, the style attached to a thin metal strip breadthwise of the same like a hammer-head, substantially as described.

43. The reproducer-style attached to or in one piece with a broad and thin strip, in combination with a diaphragm or device upon which the reproduced sonorous vibrations are to be impressed and a spring carrying said style and strip, and serving as a hinge to permit them to vibrate, substantially as described.

44. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced sonorous vibrations are to be impressed by said style, of a flat metal spring interposed between the style and diaphragm and forming a yielding connection, through which the reproduced vibrations are transmitted, said spring having a practically rigid connection with the diaphragm, substantially as described.

45. The combination, with the reproducer-style and the diaphragm or device upon which the reproduced vibrations are to be impressed by said style, of a metal spring or spring-tongue whose normal vibration is quicker than that of said diaphragm, and whose tension tends to move the style away from the diaphragm, substantially as described.

46. In combination with a diaphragm, a frame having a concave seat for said diaphragm, the walls of said seat converging to an opening in the back, through which the sound may escape, substantially as described.

47. The combination, with the diaphragm and the frame having a concave seat for said diaphragm, of a spring for holding the diaphragm to its seat and for straining the same, substantially as described.

48. The combination, with the diaphragm, its supporting-frame, and the style, of the spring for straining said diaphragm, substantially as described.

49. The combination, with the diaphragm and its supporting-frame, of the spring pressing inward on said diaphragm and the style carried by said spring, substantially as described.

50. The combination, with the diaphragm and its frame, of the spring projecting over said diaphragm, the block between the spring and diaphragm, and the style bearing upon the spring beyond said block, substantially as described.

51. The combination, with the reproducer-style, of the hard-rubber diaphragm and the frame for supporting said diaphragm at the edges, substantially as described.

52. The combination, with a diaphragm and its frame, of a spring projecting over said diaphragm, a style carried by said spring, and a block between the diaphragm and spring, adjustable lengthwise of the latter, substantially as described.

53. The combination, with the reproducer, of the guard fastened over the face of the same, substantially as described.

54. The reproducer provided with a guard

fastened over the face of the same, and curved to form horns upon which the reproducer may rest, substantially as described.

55. The double ear-piece, comprising the elastic and flexible hollow branches provided each with a cup connected with the branch by a ball-and-socket joint, substantially as described.

56. The combination, with the reproducer and the carrier therefor and the feed-screw for moving them, of a sound-conveying tube on the machine-frame and a flexible sound-conveyer between the reproducer and the said tube, substantially as described.

57. The combination, with the reproducer, of the double ear-piece comprising the elastic and flexible hollow branches and the cups jointed to the ends of said branches, substantially as described.

58. The combination, with the feed-screw and the reproducer-carrier supported and capable of turning on said screw, of the reproducer hinged to said carrier and a stop for lifting the reproducer when the carrier is turned in the proper direction, substantially as described.

59. The combination, with the feed-screw and the reproducer-carrier engaging and capable of turning on said screw and provided with an extension or tail, of a movable bar under said tail for upholding the same, so that by depressing said bar the carrier can be turned and lift the reproducer from the tablet, substantially as described.

60. The combination of the feed-screw, the reproducer-carrier mounted thereon and provided with an extension or tail, and the bar under said tail for upholding the same, substantially as described.

61. The combination, with the reproducer-carrier, of the reproducer mounted on a standard hinged to said carrier, said standard being provided with a thumb-piece or device, whereby the reproducer can be held up in placing the reproducer on and in removing it from the machine, substantially as described.

62. The combination, with the tablet, tablet-holder, feed-screw, gearing, reproducer, and reproducer-carrier, of the mechanism for controlling the rotation of said feed-screw the same being connected with said carrier so as to lift the reproducer from the tablet when operated to stop or to reverse the rotation of said screw, substantially as described.

63. The combination, with the tablet-holder and the feed-screw, of the gearing for rotating the feed-screw in the forward direction, the hinged frame for disengaging said gearing when moved a certain distance, and additional wheels connected with said frame, so as by a further movement to engage said wheels and reverse the rotation of said screw, substantially as described.

64. The combination, with the sound recorder or reproducer, the tablet, the tablet-holder, the feed-screw, the gearing for rotating the same in a forward direction, the gearing for rotating the same backward at a greater speed, and mechanism for bringing the latter into action, substantially as described.

65. The combination, with the reproducer and a conveying-tube for the reproduced sounds, of a stop-cock in said tube for moderating at will the loudness of the sounds to be conveyed to the ear, substantially as described.

66. The herein-described improved recording and reproducing machine, comprising the following elements in combination: a hollow cylindrical self-sustaining tablet, a tablet-holder journaled and hinged at one end to the machine-frame and journaled and detachably connected with said frame at the other, a feed-screw, gearing for rotating the said screw in either direction according to the wheels engaged, a hinged frame for controlling the rotation of said screw, and the recording and reproducing instruments with their carriers, substantially as described.

In testimony whereof I have signed the foregoing specification in the presence of two subscribing witnesses.

SUMNER TAINTER.

Witnesses:
PHILIP MAURO,
O. J. HEDRICK.

(No Model.)

T. A. EDISON

PROCESS OF DUPLICATING PHONOGRAMS.

No. 382,419. Patented May 8, 1888.

Fig. 1.

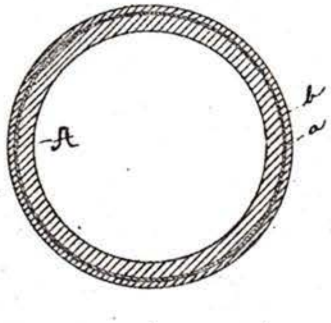


Fig. 2.

Fig. 3.

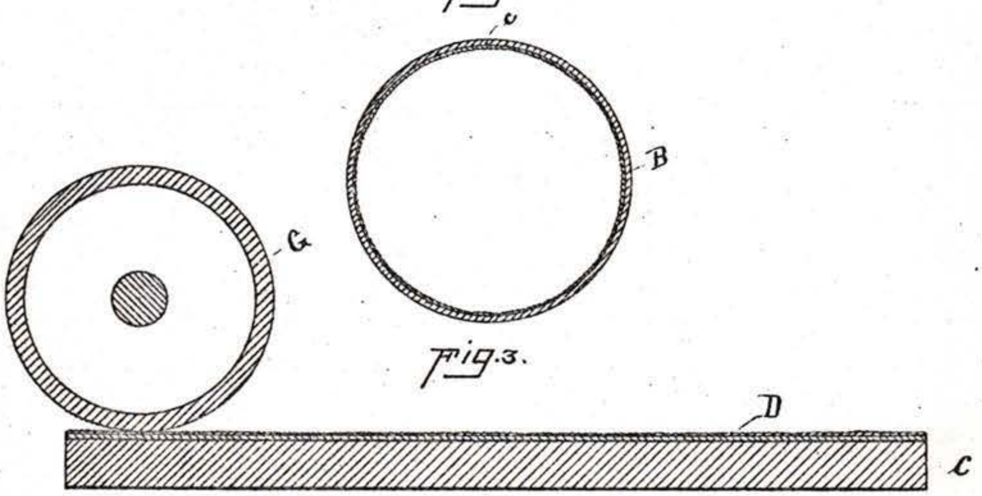
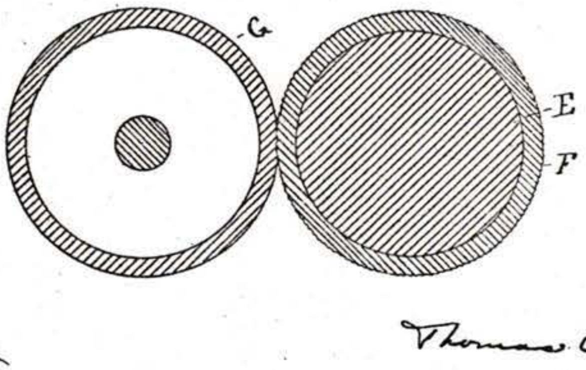


Fig. 4.



Witnesses
E. C. Rowland
William Pelzer

Inventor.
Thomas A. Edison.
By his Attorneys Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 382,419, dated May 8, 1888.

Application filed March 8, 1888. Serial No. 266,596. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes for Duplicating Phonograms, (Case No. 765,) of which the following is a specification.

The object of my invention is to produce a simple and efficient process for duplicating phonographic records. In applications already filed by me I describe a process for duplicating phonograms, wherein a metallic matrix is formed by depositing metals over the surface of cylindrical wax phonograms and then dissolving out the wax, leaving a hollow matrix or mold with the record in relief upon its inner surface. By my present invention I propose to apply the process of knurling to the duplication of phonograms as distinguished from molding. In my English Patent No. 1,644 of 1878 I proposed to construct a knurl by depositing métal over the record; but it is obvious that if this deposit were made of any thickness at all the record would be largely obliterated.

By my present invention I deposit metals over the record of the recording-surface of a cylindrical wax phonogram, and after melting out the original wax I divide the remaining cylinder by splitting it longitudinally with a thin saw on one side. I then open the cylinder out flat or further bend it into the form of a cylinder, with the record upon its exterior. To give the necessary strength I provide a suitable backing. The result is a flat or cylindrical knurling surface having the record in relief, so that by rolling a wax phonogram-blank upon it the original record will be reproduced.

For making the first deposit upon the original wax phonogram I prefer to employ silver, which is deposited upon the wax phonogram by the vacuum process or by electroplating. A thin coating is produced in this way, which is backed up by a coating of lead or tin, which is also quite thin. For example, it may be one-sixteenth of an inch in thickness. The silver gives an inoxidizable surface, which is cheaper than gold or platinum. After the wax is dissolved out and this cylinder split on one side it will be found to have sufficient flexibility by reason of the materials employed and the thinness of the cylinder to permit of its being bent without injury to the record into the form of a flat sheet or a reversed cylinder. If bent around a cylinder it will be secured to the same by cement, and if bent into a flat sheet it will likewise be secured to a suitable bed-plate, the cylinder or bed-plate giving the necessary strength to the record. The duplicate phonogram-blanks upon which I impress the original record by means of the knurl are preferably of a wax composition, which is too hard to be practically indented directly in the phonograph, although softer compositions may be employed, or materials other than wax.

In the accompanying drawings, forming a part hereof, Figure 1 is a sectional view showing the original phonogram with the deposit thereon; Fig. 2, a similar view with the original phonogram melted out or removed from the encircling metal deposit. Fig. 3 is a sectional view illustrating the flat knurling-surface, and Fig. 4 a similar view illustrating the cylindrical knurling-surface.

A is the original wax phonogram, upon the surface of which is the phonographic record, upon which is formed a thin deposit of silver, *a*, and over this a thicker deposit of lead or tin, *b*, the entire metallic deposit being, for illustration, one-sixteenth of an inch thick. After this deposit is made the wax cylinder A is melted out of the metal coating, leaving the metallic cylinder B (shown in Fig. 2) with the record in relief upon its inner surface. This cylinder B is split longitudinally on one side at the point *c*, and it is then bent out flat and mounted upon a suitable base plate, C, to which it is secured by cement, forming a flat knurling-surface, D; or the cylinder B may be bent reversely over a solid cylinder, E, and secured thereto by cement, forming a cylindrical knurl, F. (Shown in Fig. 4.) The wax duplicate phonogram-blank G is impressed with the original record by rolling it against the flat or the cylindrical knurling surface, as will be readily understood.

I do not claim herein the method of duplicating phonograms by depositing metals upon a cylindrical wax phonogram and then melting or dissolving out the original wax phonogram, leaving a matrix with the record in relief upon its inner surface; neither do I claim

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herein the use of a vacuum deposit for producing a coating upon the wax phonogram; neither do I claim herein a duplicate phonogram constructed of a hard material not capable of being satisfactorily indented by a phonograph, since these features are covered in my applications Nos. 743, 744, and 751, already filed by me. Such applications have respectively the Serial Nos. 259,895, 259,896, and 262,428.

What I claim as my invention is—

1. The process of duplicating phonograms, consisting in forming a knurl having the original record in relief by depositing metal upon the original record, removing the original phonogram and opening the metallic coating, and then impressing duplicate phonogram-blanks with the original record by means of such knurl, substantially as set forth.

2. The process of duplicating phonograms, consisting in depositing a flexible metallic coating upon an original cylindrical phonogram, removing the original phonogram from the inclosing-coating, splitting the inclosing-coating longitudinally, bending the same to form a knurl, and then impressing the duplicate phonogram-blanks with the original record by means of this knurl, substantially as set forth.

This specification signed and witnessed this 3d day of March, 1888.

THOS. A. EDISON.

Witnesses:
WM. PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PHONOGRAM BLANK.

No. 382,462. Patented May 8, 1888.

Fig. 1.

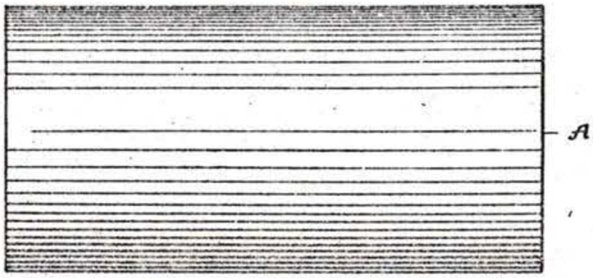


Fig. 2.

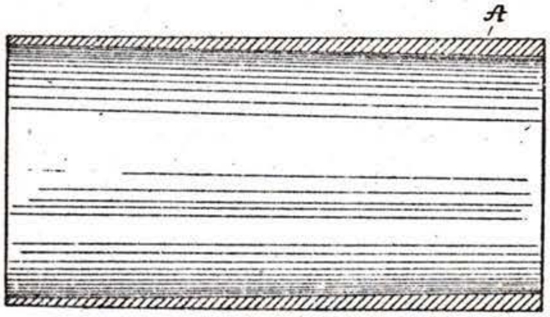
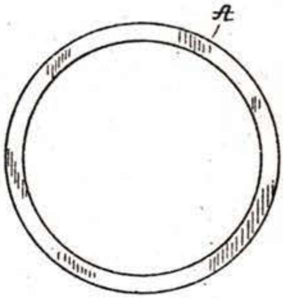


Fig. 3.



Witnesses.
E. C. Rowland,
William Pelzer.

Inventor.
Thomas A. Edison.
By his Attorneys Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 382,462, dated May 8, 1888.

Application filed January 5, 1888. Serial No. 259,898. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks and Phonograms, (Case No. 747,) of which the following is a specification.

I have found in practice that the most available surface for phonogram-blanks and phonograms is one composed of wax, gum, or other plastic hydrocarbon. Such compounds, however, I find contract and expand under variations of temperature to a much greater extent than paper, wood, metals, and other similar hardersubstances. While under ordinary conditions the wax or wax-like surface may not be injured by this difference in the coefficient of expansion, yet when subjected to extreme cold the contraction of the wax is so much greater than the harder backing that the wax will crack and destroy the continuity of the surface. For instance, a phonogram-blank or phonogram may be subjected to a temperature of nearly 100° Fahrenheit at one time and at another time the temperature may fall below zero. If the waxy substance is sufficiently hard at the high temperature to hold its shape under the pressure of one on the other in a packing-box, it will at the low temperature harden and contract so greatly in excess of the backing of harder material that the wax will crack and render the surface useless.

The object I have in view is to produce a phonogram-blank or phonogram which will have the wax or wax-like surface and will not be subject to the objection that has been stated. This I accomplish by constructing the phonogram-blank or phonogram wholly of the wax or wax-like material. I prefer to mold the entire phonogram-blank of the one wax-like compound; but I may construct the base or backing of the surface of a somewhat different mixture of wax or wax-like materials than that of which the surface is made, so long as the whole has substantially the same coefficient of expansion.

My phonogram-blank I prefer to mold as a hollow cylinder with a tapering bore for slipping over the tapering phonogram-cylinder of my phonograph.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of the phonogram-blank; Fig. 2, a longitudinal section thereof, and Fig. 3 an end view.

A is the cylindrical phonogram-blank, molded of the plastic wax or wax-like material, as described, and having a tapering bore.

The invention is also applicable to duplicate phonograms having the phonographic record thereon.

What I claim is—

1. A phonogram-blank or phonogram constructed wholly of wax or wax-like materials and having the same coefficient of expansion throughout its mass, substantially as set forth.

2. A phonogram-blank or phonogram constructed as a hollow cylinder wholly of wax or wax-like materials and having the same coefficient of expansion throughout its mass, substantially as set forth.

3. A phonogram-blank or phonogram constructed as a hollow cylinder, with a tapering bore wholly of wax or wax-like materials, and having the same coefficient of expansion throughout its mass, substantially as set forth.

This specification signed and witnessed this 5th day of December, 1887.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

G. H. HERRINGTON.

PROCESS OF DUPLICATING PHONOGRAMS.

No. 399,264. Patented Mar. 12, 1889.

Fig. 1.

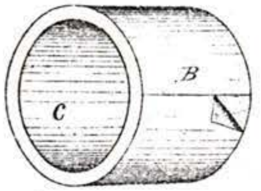


Fig. 2.

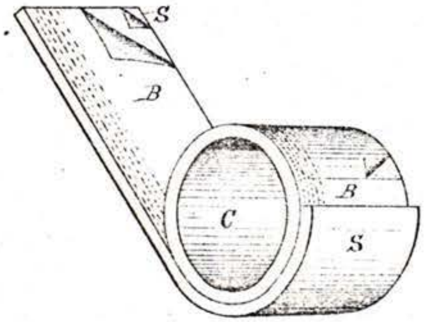
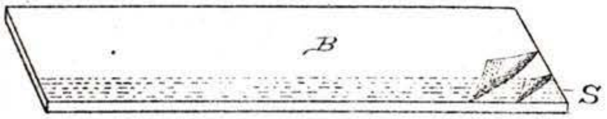


Fig. 3.



Witnesses.
F. E. A. Smith
J. G. Bobb

Inventor.
George H. Herrington.
By Wm. J. Hutchins
Atty.

UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF WICHITA, KANSAS.

PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 399,264, dated March 12, 1889.

Application filed September 21, 1888. Serial No. 285,977. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. HERRINGTON, a citizen of the United States of America, residing at Wichita, in the county of Sedgwick and State of Kansas, have invented certain new and useful Improvements in the Process of Making Duplicate Copies of Phonograms, of which the following is a specification, reference being had therein to the accompanying drawings and the letters and figures of reference thereon, forming a part of this specification.

This invention relates to certain improvements in the process of making duplicate copies of phonograms; and it consists, first, in preparing a phonograph-cylinder with a coating of wax or composition which is adapted to be softened by heat and become set and hard when cool; second, in covering said prepared cylinder with layers of tin-foil, upon which the phonogram-registrations are made while the wax or composition is soft; third, in covering said registered tin-foil with a coating of wax or composition which is adapted to be likewise softened by heat, and in removing said last covering, which serves as a matrix or shield for the tin-foil, together with one or more layers of tin-foil, when the said wax or composition is in a partially-cooled state, and in placing said matrix or shield with its layers of tin-foil upon a plane surface with the negative surface of its registrations presented, and, lastly, by making from the registered layer or layers of tin-foil duplicate copies of the phonogram-record by rolling cylinders prepared with a coating of wax or composition across the surface of said registered foil, impressing positive characters of the phonogram-record in the surface of said cylinders while they are in a soft state, after which they are permitted to harden to retain the impressed characters, or the tin-foil may be removed from the matrix or shield and placed about a cylinder, and thus present the positive phonogram-duplicate upon the surface of said second cylinder, or in making casts of wax or composition when in a soft state in the form of sheets upon the negative surface of said registered tin-foil as it rests upon its matrix or shield, and applying said casts about cylinders while in a flexible state and permitting them to harden upon their cylinders, and thus produce duplicate copies of the original phonogram. The duplicate copies of the original phonogram thus produced are adapted to be used in other phonographs or apparatus at distant places or at various places and times for reproducing the sound-vibrations of the original phonogram.

Figure I represents the cylinder of a phonograph, having a covering of either tin-foil, silver-leaf, or an equivalent material. Fig. II represents the process of making a reverse duplicate copy of a phonogram, and Fig. III represents the copying material after the impression is made and it has been removed from the cylinder.

Referring to the illustrations, C represents the cylinder of a phonograph.

B represents a thin sheet of either tin-foil, silver-leaf, or an equivalent material, and is shown in Fig. I as placed smoothly and closely about said cylinder, forming a surface upon which the phonogram is registered.

Referring particularly to Fig. II, the cylinder is shown with a covering of two or more thicknesses or layers of tin-foil, which have registered thereon the original phonogram. A covering or sheet of copying material, S, consisting of either wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent, which is adapted to be softened by means of heat or otherwise, is also shown as being impressed or formed with a duplicate negative copy of the original register and partially removed, removing with it one or more of the sheets of tin-foil, which have an impressed duplicate copy of the original register. Said copying material S, when applied in copying, is softened or used in a soft state and hardened or permitted to harden while in contact with the phonogram which it is copying, to insure perfect well-developed characters in the copy, thus forming a matrix or shield about said registered tin-foil before it is removed from the cylinder. After said material is removed from the cylinder with its impressed or formed characters, it is presented, as shown in Fig. 3, with a fine duplicate negative copy of the original phonogram upon its surface. By removing one or more layers of tin-foil from the original phonogram-cylinder with the matrix or shield it is evident that the negative surface of the registrations of said foil will be presented, and their positive surface will be in contact with each other, with one in contact with the matrix or shield; and when said shield is in a hard state cylinders prepared with said wax or composition surface, when softened by heat, may be rolled across said registered foil with pressure sufficient to impress the registrations in the surface of said cylinders and closely press the tin-foil against them, and when said foil is permitted it will adhere to said cylinders and separate from its fellow layers and become the presented surface of the duplicate. If but a single layer of said registered foil is removed with the shield, the said foil may be treated with dilute glycerine or vaseline and duplicate copies produced, in the manner last described, excepting that the tin-foil will be permitted to remain in contact with its shield and the registrations made direct upon the surface of the duplicate cylinder.

The cylinder upon which the tin-foil is placed is first treated to either a coat of soft wax or with one or more of the said copying materials or their compound or equivalent; and when it is desired to register the phonogram thereon, if said coating is other than a soft material, it is softened by means of heat or otherwise, so it will properly receive and retain the register. If desired, soft wax may be employed for making duplicate copies of the original phonogram in a similar manner and in place of other material, as above stated. At times when it becomes necessary to remove the tin-foil from the cylinder having the original phonogram or from the copies thereof it may be done by treating the tin-foil with mercury without injury to the register.

One or more layers of thin tin-foil or an equivalent may be placed about the cylinder, and when the phonogram is registered thereon each layer of the tin-foil will receive and retain a duplicate copy thereof; also, the said register is impressed into the wax or composition on the cylinder beneath said layers of tin-foil.

When desired to prevent the tin-foil from sticking to the cylinder, so it may be easily removed, the cylinder is first subjected to dilute glycerine or vaseline on the face of the wax or composition. Said layers of tin-foil may be removed from the cylinder having the original phonogram thereon in duplicate pairs or singly; but before removing them they are covered with a coat or covering of either wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent, which is applied in a soft state and hardened or permitted to harden and form a shield to protect their register and form, after which they may be opened at their union, removed from the cylinder having the original record, and placed or impressed about a second cylinder, and after they become properly impressed or seated upon said second cylinder said shield is removed, taking with it one or more of said sheets of tin-foil, and either leaving a covering of tin-foil having a duplicate record of the original phonogram thereon or impressing a duplicate copy of the original phonogram upon the surface of said second cylinder.

The object of this invention is principally to produce duplicate copies of original phonograms for the purpose of distribution or otherwise to reproduce the sound-vibration in a phonograph as registered on the original phonogram or any machine calculated to register the sound waves or vibrations, as in telegraphic, electric, and other minute operations of similar character; and the essential features of this invention consist in the use of tin-foil, silver-leaf, or some equivalent material for covering the phonograph-cylinders, and in the use of copying material, as above described, for receiving and retaining the copies in the manner stated.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows:

1. The herein-described process of making duplicate copies of original phonograms, consisting in preparing a phonograph-cylinder with a coat of wax or compound equivalent, in placing about said cylinder one or more layers of tin-foil, or an equivalent, thus forming a surface upon which to register the original phonogram, in covering said tin-foil having the original register thereon with a coat or covering of either wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent to form a shield to protect their impressed characters and form, and in removing said shield and tin-foil, and in placing or impressing said shield and tin-foil about a duplicate cylinder, in the manner substantially as and for the purpose specified.

2. The herein-described process of duplicating copies of phonograms, consisting in preparing a phonograph-cylinder with a coating of wax or composition which is adapted to be softened by the influence of heat, in placing layers of tin-foil or an equivalent about said prepared cylinder, thus forming a surface upon which to register the original phonogram, and in removing said layers of foil after the record has been made from the original cylinder and placing them about duplicate cylinders, thus forming duplicate copies of the original phonogram, substantially as and for the purpose specified.

GEORGE H. HERRINGTON.

Witnesses:
F. E. A. SMITH.
J. G. BABB.

(No Model.)

G. H. HERRINGTON.

PROCESS OF DUPLICATING PHONOGRAMS.

No. 399,265. Patented Mar. 12, 1889.

Fig. 1.

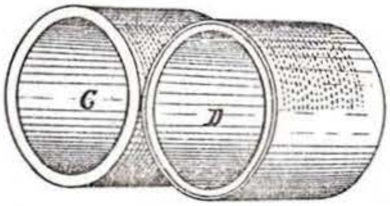


Fig. 2.

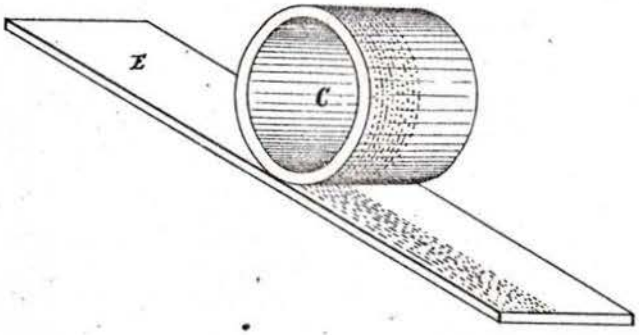
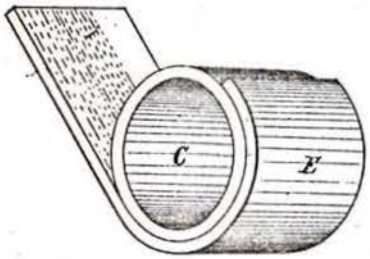


Fig. 3.



Witnesses.
F. E. A. Smith
J. G. Babb.

Inventor.
George H. Herrington.
By Wm. J. Hutchins.
Att'y.

UNITED STATES PATENT OFFICE.

GEORGE H. HERRINGTON, OF WICHITA, KANSAS.

PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 399,265, dated March 12, 1889.

Application filed September 21, 1888. Serial No. 285,978. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. HERRINGTON, a citizen of the United States of America, residing at Wichita, in the county of Sedgwick and State of Kansas, have invented certain new and useful Improvements in the Process of Making Duplicate Copies of Phonograms, of which the following is a specification, reference being had therein to the accompanying drawings and the letters and figures of reference thereon, forming a part of this specification.

This invention relates to certain improvements in the process of making duplicate copies of phonograms; and it consists, first, in preparing a phonograph-cylinder with a coating of wax or composition which is adapted to be softened by heat, in registering the sound-waves from a phonograph upon said prepared cylinder while its wax or composition is in a soft state, then in permitting said wax or composition to cool and harden and thus preserve its developed characters; second, in preparing sheets of said wax or composition, in softening said sheets by means of heat, and applying and pressing them about the cylinder having the original phonogram, or rolling said cylinder across said sheet with pressure to impress the phonogram-registrations upon the surface of said sheets, when the sheets are permitted to harden or set, and if about said cylinder removed, and thus said sheets are impressed with a negative duplicate copy of the original phonogram; and, third, in preparing duplicate cylinders with a coating of said wax or composition, and while they are in a soft state from the influence of heat they are either rolled across the sheet having the negative copy or said sheets placed about said cylinders, and in either instance pressure is applied sufficiently to impress a positive duplicate copy in the surface of said duplicate cylinders from the said negative copy. Then each is permitted to set or harden to preserve the duplicates thus obtained.

Figure 1 represents the process of copying the registrations of the sound-vibrations of an original phonogram upon the surface of a cylinder of similar dimensions by means of compression. Fig. 2 represents a similar process of copying said registrations upon a plane surface, and Fig. 3 represents the process of copying said registrations upon a plane sheet of the copying material by means of placing said material about the cylinder having the original record thereon and by holding said material compressed thereabout until the characters are developed.

Referring to the illustrations, *c* represents a phonograph-cylinder having registered thereon the original phonogram.

D represents a cylinder of similar dimensions having a coat or covering of either wax, resin, pitch, celluloid, glue, rubber, or their compound, or some equivalent material adapted to be softened by means of heat or otherwise, so it will receive and retain the impression in reverse duplicate of the record made on the original phonogram by means of rolling the surfaces of the said two cylinders together with sufficient pressure to properly cause the record to be copied. (See Fig. 1.)

E represents a prepared sheet or plane surface of either wax, resin, pitch, celluloid, rubber, or their compound, or some equivalent material, as before stated, which is adapted to be softened by means of heat or otherwise and used in some instances in place of the cylinder D for receiving and retaining in reverse duplicate the record made on the original phonogram by means of rolling the cylinder having the original record over the surface of said sheet or plane with sufficient pressure to properly cause the record to be copied, as in the former manner, (see Fig. 2,) and thus by the process described a fine reverse duplicate or negative of the original phonogram is produced, and when the said copying material upon which the copy is made becomes cool it will set and become firm and retain a rigid copy. In instances where certain kinds of said copying material are used which will form into flexible sheets it is placed about the cylinder having thereon the original phonogram while soft and retained thereon by suitable pressure until the copy has been impressed and the material has become set and the several characters well developed. (See Fig. 3.)

To produce positive duplicates of the original phonogram, duplicate copying cylinders or sheets are prepared in like manner as above described and subjected to the same process and pressure in contact with the cylinder or sheet having the reverse or negative copy of the original phonogram thereon, and when the positive duplicate copies of the original phonogram have set and their registrations have become firm they may be used in reproducing the sound-vibrations in a phonograph.

Any desired number of positive duplicate copies of the original phonogram may be made from the reverse or negative copy thereof in the manner and by the process stated. Duplicate positive copies of the original phonogram may be made from the reverse or negative duplicates thereof on soft wax.

The essential features of my invention consist in using one or more of the materials as follows: wax, resin, pitch, celluloid, glue, rubber, or their compound or equivalent, applied to a cylinder or roll or formed in plane sheet or strips, wherein they are adapted to be softened by means of heat or otherwise, so as to receive and retain, first, the reverse duplicate copy of the original phonogram, and, second, by using the said reverse duplicate copy for producing positive duplicate copies of the original phonogram.

The use to which this process of duplicating the registrations of the sound waves or vibrations is applied is in phonographs or any machine calculated to register sound waves or vibrations, as in telegraphic, electric, and other minute operations of similar character.

I am aware of the use of plastic material and materials adapted to be softened in various ways and impressed with characters and permitted to set or harden while in contact with the object of which the impression is taken; but I am not aware that the herein-described process has heretofore been used, wherein a phonograph-cylinder is first covered with a coating of wax or composition which is adapted to be softened by heat and the phonogram-record made thereon while said coating is softened from the influence of heat, then permitted to harden, then in preparing sheets or strips of said wax or composition material and applying said sheets in contact with the original recorded cylinder when in a soft state from the influence of heat, thus impressing said sheet with a negative copy of the original record, then permitting said sheet to set to preserve the form of its copy, and removing it apart from the original record and applying duplicate cylinders, which are prepared with a coating of said wax or composition, in contact with said negative copy of said sheet while said duplicate cylinders are softened from the influence of heat, so they will receive in their surface an impressed positive duplicate copy of the original phonogram, and then permitted to harden to preserve such copy, thus producing any number of positive duplicate copies of the original phonogram-record in such form as that it may be used in reproducing the sound-vibrations in a phonograph.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is as follows, to wit:

1. The herein-described process of making duplicate copies of original phonograms, consisting in preparing a phonograph-cylinder with a coating of wax or composition which will soften under the influence of heat, thus forming a surface upon which to register the phonogram when said surface is in a soft state, then permitting said recorded surface to harden, in applying a sheet or strip prepared from said wax or composition, while in a soft state from the influence of heat, in contact with said hardened recorded surface of the original phonogram, impressing said sheet or strip with said record, and while in such contact permitting the wax or composition to set, in removing said impressed sheet or strip from contact with the record, thus producing a negative duplicate copy; and in applying duplicate cylinders having a coating of said wax or composition in contact with said negative copy while the coatings of said cylinders are softened from the influence of heat, impressing in their surface a positive duplicate copy of the original phonogram from said negative, substantially as and for the purpose specified.

2. The herein-described process of making duplicate copies of original phonograms, consisting in pressing sheets of wax or composition which is adapted to soften from the influence of heat in contact with the original phonogram while in a soft state, then permitting it to set, thus impressing said sheet with the original record, in removing said sheet or strip from contact with the original record, thus forming a negative duplicate copy, and in applying duplicate cylinders having a coating of said wax or composition in contact with said negative copy while the coatings of said cylinders are softened from the influence of heat, thus impressing in their surface a positive duplicate copy of the original phonogram from the negative record, substantially as and for the purpose specified.

GEORGE H. HERRINGTON.

Witnesses:
F. E. A. SMITH,
J. G. BABB.

Complainants' Exhibit, Edison
Patent No. 430,274, June 17 - 1890.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 430,274, dated June 17, 1890.

Application filed July 30, 1888. Serial No. 281,454. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks, (Case No. 793,) of which the following is a specification.

My invention relates to phonogram-blanks for receiving a record of sound-vibrations and reproducing the same; and my object is to produce blanks having superior qualities for recording and reproducing such vibrations.

To this end my invention consists, mainly, in making such blanks, which are preferably of cylindrical form, of soap of the character hereinafter described. Said material may be employed alone or mixed with other materials, such as waxes, resins, or gums.

Insoluble soap may be formed of any metal or sometimes of an earthy oxide, like lime, in combination with any fatty acid. For my purpose, however, it is best to use lead, magnesium, or aluminium, combined with oleic or stearic acid, forming an oleate or stearate of the metal used. These compounds are preferred because of their superior amorphous quality. Of the metals named I especially prefer to employ lead, and especially to use a mixture of equal quantities of oleate and stearate of lead, the same being melted and poured into molds to form the cylindrical blanks.

The soap may be made according to the usual well-known methods.

What I claim is—

1. Phonogram-blanks made of metallic soap, substantially as set forth.

2. Phonogram-blanks made of lead soap, substantially as set forth.

3. Phonogram-blanks made of a mixture of oleate and stearate of lead, substantially as set forth.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

L. F. DOUGLASS.

METHOD OF AND MEANS FOR DUPLICATING OR TRANSFERRING PHONOGRAPHIC RECORDS.

No. 475,490. Patented May 24, 1892.

Fig. 1.

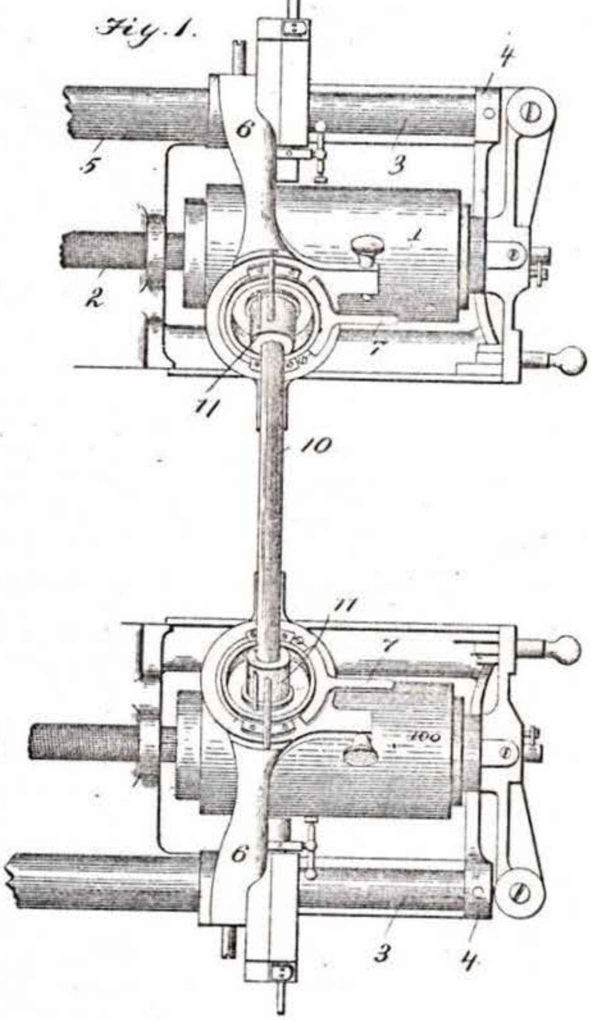
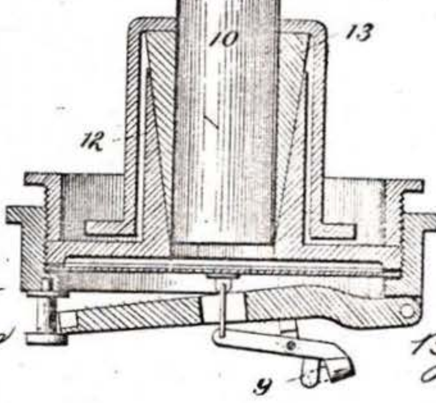

4
6
5
3
1
2
7
11
10
11
7
100
6
3
4

Fig 2



Witnesses
G. R. Cornwall
Edwin L. Bradford

Inventor
Leon F. Douglass
By F. W. Ritter Jr.
Attorney

UNITED STATES PATENT OFFICE.

LEON F. DOUGLASS, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO EDWARD D. EASTON, OF SAME PLACE.

METHOD OF AND MEANS FOR DUPLICATING OR TRANSFERRING PHONOGRAPHIC RECORDS.

SPECIFICATION forming part of Letters Patent No. 475,490, dated May 24, 1892.

Application filed March 17, 1892. Serial No. 425,259. (No model.)

To all whom it may concern:

Be it known that I, LEON F. DOUGLASS, a citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Methods of and Means for Duplicating or Transferring Phonographic Records; and I hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled int he art to which it appertains to make and use the same.

My invention relates to a new and useful method of duplicating or transferring phonographic records; and it consists, generally stated, in delivering the sound-waves emitted by the reproducing-diaphragm to a receiving-diaphragm carrying the cutting-stylus, which causes said diaphragm to move successively or in the order of the force of the sound-waves and cut like forms of sound-waves upon the receiving phonogram-blank, thus making a duplicate of the record.

A second feature of the invention resides in providing means for confining and directing the sound-waves from one diaphragm to the other.

A third feature resides in delivering the sound-waves through a channel or conduit of rarefied air or air at a reduced pressure, and, finally, in the construction and arrangement of the several parts, whereby these features are obtained, all as will hereinafter be described, and afterward pointed out in the claims.

In the accompanying drawings, forming a part of this specification, like symbols of reference refer to like parts wherever they occur, in which—

Figure 1 is a plan view showing the diaphragms in position on the respective cylinders and the flexible conduit for conducting the sound-waves from one diaphragm to the other. Fig. 2 is a cross-section through one of the diaphragms, showing the air-tight connection of the conduit therewith.

In the drawings, 1 indicates the phonogram-record, mounted upon a mandrel of any ordinary or approved construction, which is turned by the screw-shaft 2 in the usual manner.

3 is the guide-rod, mounted in supports 4, upon which is mounted the sleeve 5, carrying the arm 6, which supports and carries the diaphragm or reproducer, said arm and its contained diaphragm or reproducer being moved along by a feed-arm (not shown) and which co-operates with the screw-shaft 3. The receiving-phonogram blank 100 is similarly mounted and operated by mechanism which may be connected with or be operated independently of the mechanism which operates the record-phonogram; but this I deem unimportant, as it forms no particular feature in this present invention.

The record diaphragm or reproducer is provided with an arm or extension 7, the function of which being to throw the reproducing-stylus 9 into or out of engagement with the phonogram-record cylinder. This arm or extension I also prefer to mount upon the receiving-diaphragm, in order that either or both diaphragms may be put into or out of engagement with their respective phonograms. I connect the reproducing and receiving diaphragms by a conduit or flexible pipe connection 10, said pipe extending through a thimble 11 and into a nose or extension 12 on the respective diaphragms.

13 indicates a conical-shaped flexible thimble or ferrule fitting tightly around the ends of the connecting-conduit 10 and into the noses 12 of the diaphragms, thus making an air-tight connection between the same and confining the sound-waves therein. I preferably rarefy or reduce the atmosphere in the conduit 10, in order to more readily transmit the sound-waves and make the diaphragms more susceptible to vibration on account of pressure of the outside air.

To reduce the air in the conduit, it is only necessary to compress the same before insertion, which will exclude a portion of the air therefrom, and the conduit will of its own assertion of elasticity resume its normal position.

I have illustrated in Fig. 1 the ordinary means of operation of the several phonograms; but I do not wish to be understood as confining myself to such construction, as it is obvious that any suitable mechanism may be substituted and employed to accomplish the same results without in the least departing from the nature and principle of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The method herein described of duplicating or transferring phonographic records, which consists in delivering the sound-waves emitted by the reproducing-diaphragm in contact with the record-phonogram to a receiving-diaphragm, which actuates the cutting-stylus in contact with the receiving-phonogram blank, thereby making a copy of said sound-waves upon the receiving phonogram-blank, substantially as and for the purposes described.

2. The combination, with the record-phonogram, of a receiving-blank phonogram, a diaphragm for receiving vibrations from the record-phonogram, and a diaphragm for transmitting vibrations or sound-wave forms on the receiving-blank phonogram, substantially as and for the purposes described.

3. The combination, with the record-phonogram, of a diaphragm adapted to be vibrated thereby, a diaphragm adapted to be vibrated by the sound-waves emitted by the first diaphragm, and a receiving-blank phonogram for receiving the vibrations from the latter diaphragm, substantially as and for the purposes described.

4. The combination, with the record and receiving-blank phonograms, of diaphragms in juxtaposition thereto, provided with reproducing and cutting styli, and a conduit of rarefied air connecting the two diaphragms, substantially as and for the purposes described.

In testimony whereof I affix my signature, in presence of two witnesses, this 16th day of March, 1892.

LEON F. DOUGLASS.

Witnesses:
WM. A. EASTERDAY,
F. R. CORNWALL.

(No Model.)

G. BETTINI.

PHONOGRAPH.

No. 488,381. Patented Dec. 20, 1892.

Fig. 1,

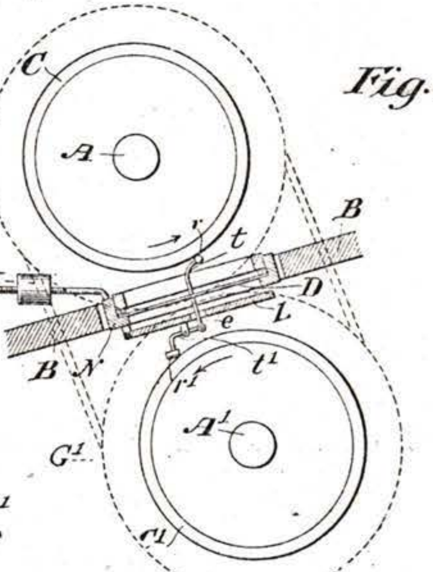

C
G
A
r
t
B
W
D
L
e
B
N
r1
t1
G1
A1
C1

Fig. 3,

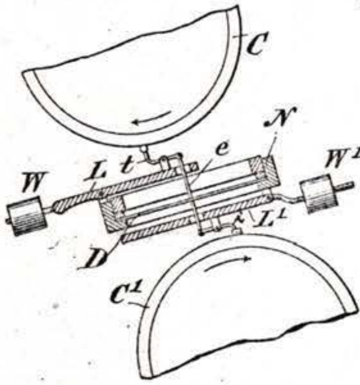

C
N
W
L
t
e
W1
L1
D
C1

Fig. 4,

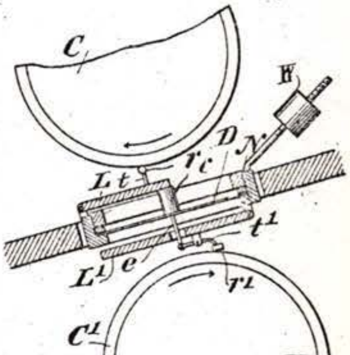
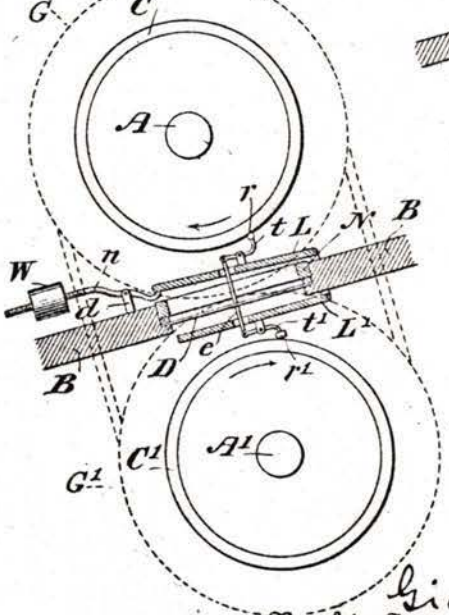

C
W
D
N
L
t
r
c
t1
L1
e
r1
C1

Fig. 2,


G
C
A
r
t
L
N
B
W
n
d
t1
L1
B
D
e
r1
C1
A1
G1

Witnesses

C. E. Ashley

H. W. Lloyd.

Inventor

Gianni Bettini

By his Attorney

Charles J. Kintner

UNITED STATES PATENT OFFICE.

GIANNI BETTINI, OF NEW YORK, N. Y.

PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 488,381, dated December 20, 1892.

Application filed March 14, 1892. Serial No. 424,815. (No model.)

To all whom it may concern:

Be it known that I, GIANNI BETTINI, a subject of the King of Italy, and a resident of New York, in the county of New York and State of New York, have made certain new and useful Improvements in Phonographs, of which the following is a specification.

My invention is directed particularly to a novel apparatus for duplicating phonographic records, and its object is to simplify and cheapen the present expensive methods of making records where it is desired to place the same record upon many phonogram surfaces or cylinders. I accomplish this object with the apparatus hereinafter described, but particularly pointed out in the claims at the end of this specification.

In order that my invention may be fully understood reference is had to the accompanying drawings, in all of which like letters of reference represent like parts wherever used.

All of the figures of the drawings (four in number) are sectional views of modified forms of my novel apparatus designed to accomplish the result above indicated—

Referring first to Figure 1—A represents he axis—and C a phonogram cylinder carried hereby, and upon which has been placed a record which it is desired to duplicate mechanically.

B B represent parts of the frame of the apparatus which sustain my reproducing device.

C′ represents another phonogram cylinder upon which it is desired to make a duplicate record, this cylinder being carried by an axis (A′) parallel to the axis (A).

G G′ are pulleys carried by the axes A and A′ and connected together by a belt or cord so that they will rotate with the axes (A and A′) and cylinders (C C′).

N is a diaphragm supporting ring in which is secured a diaphragm D, this ring being in this instance pivotally supported on an axis parallel with the axes (A and A′) and provided with a regulating arm and adjustable weight (W). To the upper side of the diaphragm is attached a record reproducing stylus (t) and to the lower side of this diaphragm is secured a pivoted recording or record producing stylus (t') the fulcrum of which is attached to a lever (L) the arrangement being such that the free end of the pivoted reproducing stylus (t') is adapted to bear upon the surface of the duplicating phonogram cylinder (C′). The lever (L) it will be observed is pivoted at one end to the ring (N), and the arrangement is such that the reproducing stylus (t') will follow accurately the movements of the stylus (t).

The operation of this apparatus is as follows:—The axis (A) is set in motion in its usual way in the direction of the arrow, the stylus (t) having been properly adjusted in connection with the original record upon the phonogram cylinder (C) and the recording or record producing stylus (t') having been properly adjusted to bear upon the surface of the cylinder (A′) with the desired pressure through the agency of the adjustable weight (W). The pulley (G) therefore, transmits to the pulley (G′) motion in the direction of the lower arrow, so that the cylinder (C′) rotates in the same direction as does the cylinder (C), and a correct record is therefore, transmitted from the stylus (t) through the link (e) and diaphragm (D) to the pivoted recording or record producing stylus (t'), thus causing the part r' to cut or produce in the cylinder (C′) an accurate duplication of the record on the cylinder (C). After the record has been thus duplicated the second cylinder (C′) may be removed and the operation repeated with duplicate cylinders for an indefinite number of times. In the form shown in Fig. 2 the diaphragm (D) is fixedly secured to the parts (B) of the frame and the adjustable feature, [which is attributable in Fig. 1 to the pivoted diaphragm, adjustable weight (W) and pivoted lever (L)] is effected through the agency of two pivoted levers (L and L′) adjustable weight (W) and a third lever (n) the latter pivotally secured to one part (B) on a standard (d) with its short arm under the free end of the upper lever (L). In this instance it will be noted that the styles (t and t') are pivoted respectively to the levers (L and L′) and are joined to each other through the agency of the diaphragm (D) and a rigid wire or connecting link (e).

The mode of operation of the form shown in Fig. 2 is not essentially different from that shown in Fig. 1.

In the form shown in Fig. 3, the diaphragm is rigidly supported, the same as in Fig. 2 and adjustable weights (W and W′) are secured to the outer ends of the levers (L and L′) the styles (*t* and *t′*) being pivotally secured to these levers and attached to each other through link (*e*) and diaphragm (D).

In Fig. 4 the diaphragm ring (N) is pivoted to the parts (B B) the same as in Fig. 1, and the stylus (*t*) is attached directly to the free end of the lever (L). This lever is pivoted at its other end directly to the diaphragm ring (N) and its free end connected directly to the diaphragm by a piece of cork (*c*), the diaphragm, in turn, being connected to the lower stylus (*t′*) by a link (*e*). The stylus (*t′*) is pivoted as in Fig. 1 to a lever (L′).

In Figs. 3 and 4, the pulleys (G and G′) are not shown although it will be understood that some means of operatively connecting the two phonogram cylinders (C C′) will always be required. Of course other means than pulleys may be utilized for rotating the cylinders (C and C′) together. The operation of these modified forms is entirely obvious in view of the description and the mode of operation of the modified forms illustrated in Fig. 1.

I do not limit myself to the specific forms of mechanism herein shown and described for duplicating phonogram records, as I believe I am entitled to claim broadly apparatus for duplicating such records through the agency of connected pivoted styles and my claims are generic in this particular.

I am aware of the record reproducing apparatus shown in Figs. 1 and 2 of the drawings of patent to S. Taintor, No. 341,287, granted May 4, 1886, and I make no claim hereinafter broad enough to include such a structure or any method involved in the use of such structure.

Having thus described my invention, what I claim and desire to secure by Letters-Patent of the United States is:—

1. A pair of independent phonogram surfaces, one of which has a record on its face; intermediate gearing as a belt and pulleys for causing said surfaces to move simultaneously; a stylus adapted to follow the conformation of the record, and a second stylus with intermediate connections adapted to reproduce the record on the second surface—substantially as described—

2. A pair of independent phonogram surfaces, one of which has a record on its face; intermediate gearing as a belt and pulleys for causing said surfaces to move together; a stylus resting on the record on the first surface; a second stylus resting on the face of the second surface, and an intermediate elastic or yielding support as a diaphragm with adjustable connections, as described—

3. A pair of independent phonogram cylinders sustained by parallel axles geared together, one of said cylinders having a record on its face; a reproducing stylus adapted to follow this record; a recording stylus attached to the reproducing stylus by intermediate connections, and adapted to make a duplicate record on the face of the second cylinder—substantially as described—

4. A pair of phonogram cylinders sustained by parallel axles geared together, one of said cylinders having a prepared record on its face; a pivoted reproducing stylus fulcrumed to a lever; a pivoted record producing stylus resting normally on the face of the second phonogram cylinder and fulcrumed to a second lever with connections between said styles, whereby a duplicate record is made upon the face of the second cylinder, as the two are revolved—substantially as described—

GIANNI BETTINI.

Witnesses:
C. J. KINTNER,
F. GRIESSMAN.

(No Model.)

T. A. EDISON.

PROCESS OF DUPLICATING PHONOGRAMS.

No. 484,582. Patented Oct. 18, 1892.

Fig. 1

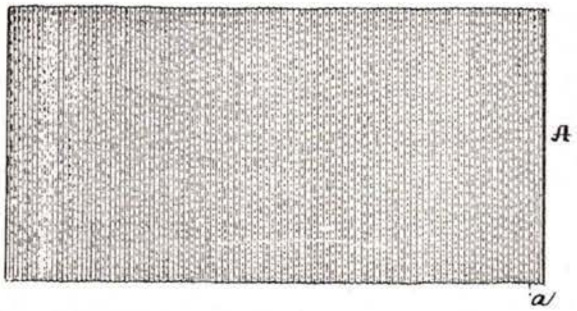


Fig. 2.

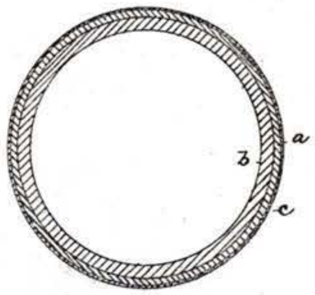


Fig. 3.

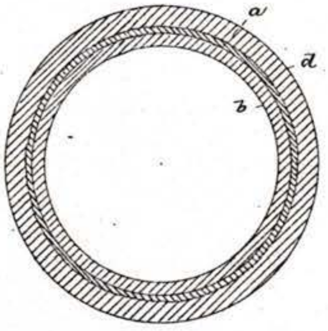


Fig. 4.

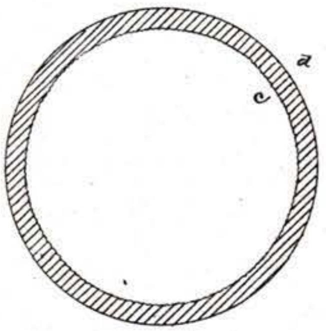


Fig. 5.

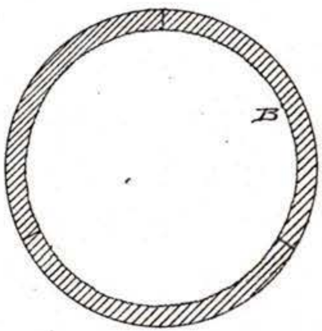


Fig. 6.

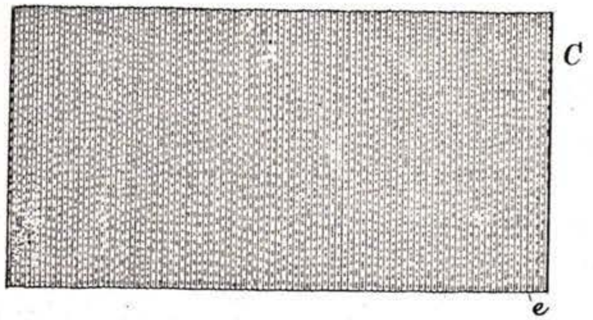
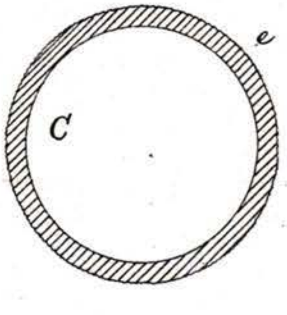


Fig. 7.



Witnesses
E. C. Rowland
William Pelzer

Inventor
Thomas A. Edison

By his Attorneys Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO
THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 484,582, dated October 18, 1892.

Original application filed January 5, 1888, Serial No. 259,895. Divided and this application filed January 30, 1888. Renewed March 30, 1892. Serial No. 427,011. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Process for Duplicating Phonograms, (Case No. 751,) of which the following is a specification.

The object I have in view is to produce a practical process for the duplication of phonographic records, so that the new art of phonographic publication can be established. Generally I propose to construct a suitable matrix, preferably in metal, and by its use mold duplicate phonograms with the phonographic records thereon, such phonograms or the surface thereof being preferably constructed of a material too hard for the satisfactory indentation thereof by the phonograph-recorder; but the duplicate phonograms may be made of a softer material. For the construction of the matrix I employ the process of vacuous deposit described in my application, Serial No. 118,942, filed January 28, 1884. The original phonogram is preferably constructed with a surface of wax or a similar material. This is placed in a suitable phonograph and the phonographic record produced thereon. The phonogram so impressed with the phonographic record is placed in a high vacuum, in which an electric arc, continuous or discontinuous, is produced between electrodes of metal or in which metal vapor is otherwise produced. The electric arc produces a vapor of the metal of which the electrodes are composed, which vapor or a metallic vapor otherwise produced within said chamber is deposited on the indented surface of the phonogram, forming a layer of metal thereon, which follows accurately all the indentations of the record, however minute, owing to the highly-comminuted condition of the metal deposited. The phonogram while the deposit is taking place in the vacuum-chamber is revolved slowly by a suitable power-connection, and this is especially necessary when the form of the phonogram is cylindrical, which it preferably is. The vacuous deposit is continued until the layer of metal is sufficiently thick, when the covered phonogram is removed from the vacuum-chamber and is further covered by a more rapid process to give strength and body to the covering. A further covering of metal may be produced by electroplating a metal upon the vacuous deposit in the usual manner of electroplating, or the vacuous deposit may be backed up by casting upon it type-metal or other metal or alloy having a lower fusing-point than the vacuous deposit, or this may be done after electroplating upon the vacuous deposit, or the vacuous deposit may be backed up by a a cement or gum or by plaster-of-paris; but a metal backing is preferred. The material of the original phonogram is then dissolved off of the metal covering, leaving in the case of cylindrical phonograms a hollow metal cylinder or one internally faced with metal, carrying the phonographic record in relief upon its inner surface. This metal cylinder is then split longitudinally by a very thin saw into a number of parts—say, for illustration, three parts—which are suitably mounted upon levers, so that a mold is formed, which can be closed to receive the material to be molded and opened to permit of its being taken out. The duplicate phonograms are produced by means of this mold by pouring therein and preferably around a suitable core placed in the mold suitable substances, such as wax or wax-like material, resin, or plaster-of-paris, the material being preferably too hard to be satisfactorily indented by the phonograph, or the duplicate phonograms may be made by taking sheets of smooth material, like waxed paper or tin-foil, and pressing them upon the surface of the mold by a plunger or otherwise, the sheets being afterward backed up by a wax, resin, or cement. The latter way of making the duplicate phonograms is especially applicable to flat-surface phonograms, although it may be used for phonograms with cylindrical surfaces. The production of the first layer of metal upon the phonograph-record by means of the vacuous deposit has great advantages over doing this by electroplating. In electroplating the wax-surface must first be covered by plumbago or gold-leaf or silver salts reduced by chemical reagents in order to form a conducting basis for the plating. The plumbago and gold-leaf do not bring out the fine vibrations and produce rough reproductions while the silver salts do not run well on the wax surface. The vacuous deposit, however, adheres uniformly to the wax surface and reproduces the record with great perfection.

The invention is illustrated for convenience in connection with a cylindrical phonogram.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of an original phonogram; Fig. 2, a cross-section of the original phonogram with a thin vacuous deposit thereon; Fig. 3, a view similar to Fig. 2, with a further backing; Fig. 4, a view the same as Fig. 3, with the original phonogram dissolved out; Fig. 5, a sectional view of the divided mold or matrix; Fig. 6, an elevation of a duplicate phonogram produced by the mold, and Fig. 7 a cross-section of such duplicate phonogram.

A is the original phonogram, having a relatively-soft wax or wax-like surface *a* and the backing of harder material *b*, or it may be entirely of wax. The phonographic record is produced upon the surface *a*. The metallic vacuous deposit is shown at *c*, and the further backing, preferably of metal, is shown at *d*.

B is the divided mold, produced as has been stated and having the phonographic record in relief.

C is the duplicate phonogram, produced by the mold and having a surface *e*, indented with the phonographic record and preferably of harder material than could be practically or satisfactorily indented directly by the phonograph.

My invention herein is limited to constructing the matrix or mold by covering the phonograph-record by a vacuous deposit.

The broad invention of duplicating phonograph-records and of producing matrices for that purpose, not limited to the use of the vacuous deposit as a step in the process of reproducing the phonographic record or constructing a matrix for that purpose, is not claimed herein, such broad subject-matter being covered by an application for patent filed by me January 5, 1888, Serial No. 259,895, of which this specification is a division.

What I claim is—

1. The process of forming a matrix or mold for the duplication of phonographic records, consisting in covering the phonograph-record with a deposit of metal by vaporizing metal in a vacuum in which the record is placed, substantially as set forth.

2. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record on a phonogram; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantally as set forth.

3. The process of forming a matrix or mold for the duplication of phonographic records, consisting, first, in indenting the original record upon a phonogram having a wax-like surface; second, covering the recording-surface of such phonogram with a deposit of metal by vaporizing metal in a vacuum in which such phonogram is placed, backing up such deposit to give it strength, and then removing the original phonogram, substantially as set forth.

4. The process of duplicating phonograms carrying a phonographic record, consisting, first, in indenting the original record upon a phonogram; second, constructing a matrix or mold of such original record by depositing thereon a coating of metal by vaporizing metal in a vacuum in which the record is placed, and, third, producing duplicate phonograms from such matrix, substantially as set forth.

This specification signed and witnessed this 17th day of January, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

T. A. EDISON.

PHONOGRAPH REPRODUCER.

No. 484,584. Patented Oct. 18, 1892.

Fig. 1.

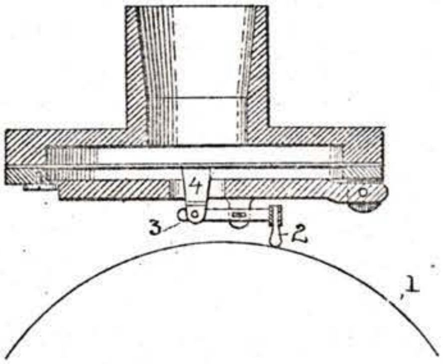
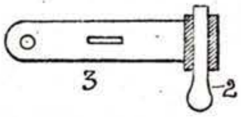


Fig. 2.



Witnesses
Norris A. Clark
Charles M. Catlin.

Inventor
T. A. Edison.
By his Attorney, Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAPH-REPRODUCER.

SPECIFICATION forming part of Letters Patent No. 484,584, dated October 18, 1892.

Application filed May 27, 1890. Renewed March 30, 1892. Serial No. 427,013. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonograph-Reproducers, (Case No. 862,) of which the following is a specification.

In practice it is found that after phonographs have been used for a time the articulation of the speech reproduced is not so smooth and clear as when the phonograph was first put in use. While the articulation is sufficiently good to be intelligible, the false vibrations are such as to cause unpleasant and some times confusing noises at the reproducer. I attribute this to the fact that by continued use the cutting-edge of the recorder and of the turning-off tool and the bearing point or end of the reproducer become roughened. The recording-surface of the phonogram-blank is ordinarily of wax or a stearate or hard metallic soap or other wax-like material or composition, and it would naturally be supposed that a tool of steel of the best quality would be entirely satisfactory for use in connection with such a comparatively-soft substance. I have, however, found that such tools are subject to the objection above set forth. This is due to the chemical action of acids or other substances found in the wax or composition of which the phonogram-blank is made, and to the dulling and roughening action of fine particles of silica or other hard material which become mixed with the wax during the manufacture of the blank or which become lodged on the surface thereof. After many trials I have found that hard crystals, earthy oxides, and gems—such, for example, as sapphire, quartz, or garnet, all of which may be termed "jewels"—co-operate in the most effective manner with the wax-like phonogram-blank, since the acids thereof do not attack them, they are not rusted by moisture, and they are adapted to withstand the dulling action of the hard particles referred to.

The present invention consists, in a reproducer for phonographs, of a jewel possessing the characteristics above mentioned.

The recorder and turning-off tool are not claimed herein, since they form the subject-matter of an application filed by me on even date herewith.

In the accompanying drawings, which illustrate the invention, Figure 1 is a view of the reproducer bearing on the surface of a phonogram-blank. Fig. 2 is a detached view, on a larger scale, of the reproducer.

1 is the surface of the phonogram-blank.

2 is the jewel reproducing-point, the bearing end of which is preferably spherical or rounded. This jewel is held in any suitable manner at one end of the pivoted lever 3, the opposite end of which is connected to the phonograph-diaphragm by means of the post 4.

Reproducing-points made as above described not only are more durable than those of metal, but they move more readily over the record and do not introduce false vibrations into sounds reproduced.

Having thus described my invention, what I claim is—

1. The combination, in a phonograph, with a phonograph-blank of wax-like material, of a jewel reproducer, substantially as described.

2. The combination, in a phonograph, with the phonogram-blank, of a rounded jewel reproducer, substantially as described.

3. A reproducer or bearing-point for phonographs, consisting of a jewel not affected by chemicals or chemical action of the wax-like material of the phonogram-blank, substantially as described.

This specification signed and witnessed this 24th day of May, 1890.

THOS. A. EDISON.

Witnesses:
A. O. TATE,
THOMAS MAGUIRE.

(No Model.)

220

E. H. AMET.

APPARATUS FOR REPRODUCING PHONOGRAMS.

No. 539,212. Patented May 14, 1895.

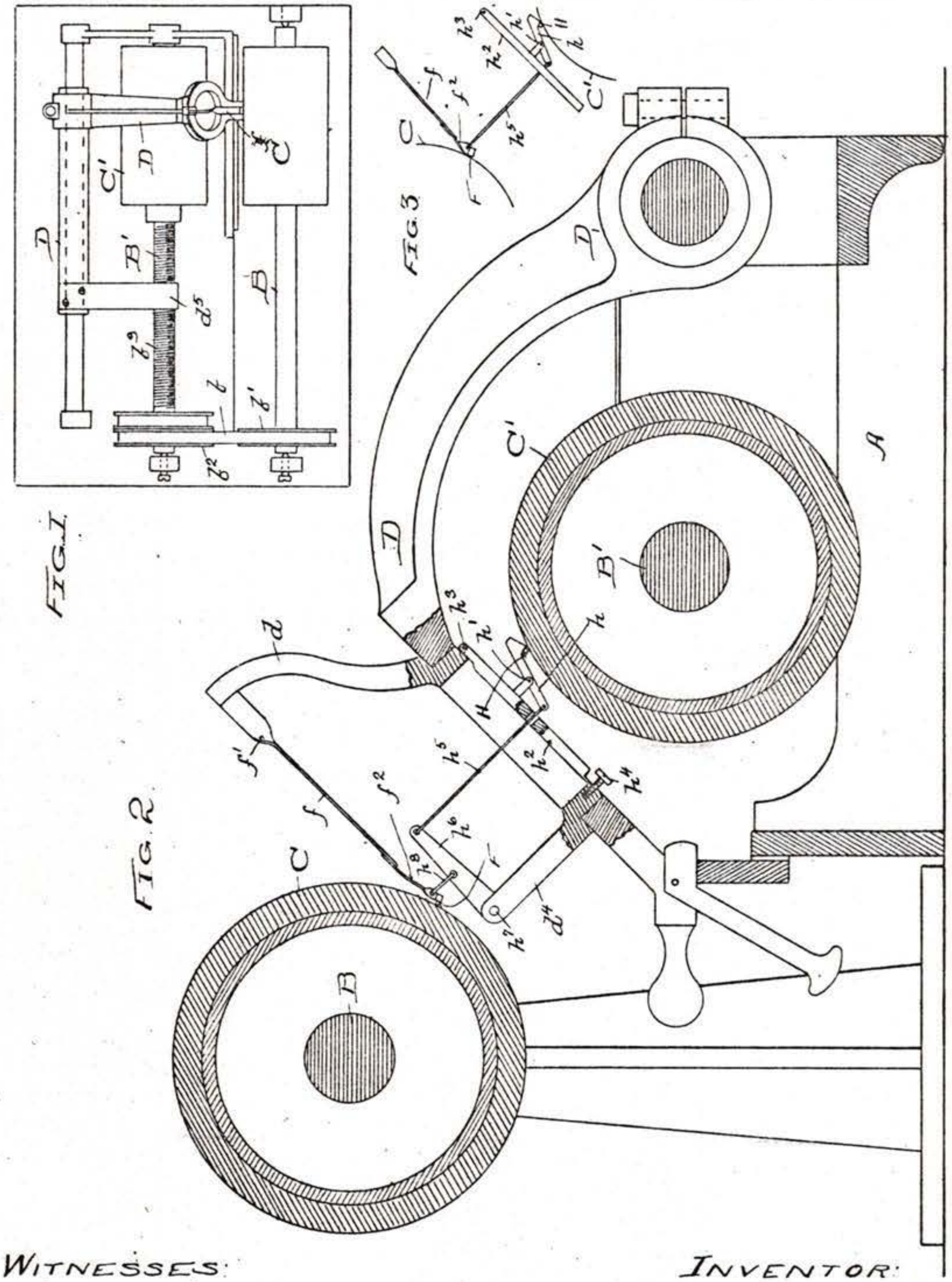

D
C'
D
C
B'
B
d5
b3
b
b'
b2

FIG. I

f
f2
C
F
h3
h2
h'
h11
h5
C'
D
C'
A
B'
h
h'
h3
d
H
f'
h5
h2
h4
f2
f
h6
r
h8
C
h2
d4
B

FIG. 3

FIG. 2

WITNESSES:
Lew. E. Curtis
W. H. Munday

INVENTOR:
EDWARD H. AMET
BY Munday, Evarts & Adcock
HIS ATTORNEYS

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

EDWARD H. AMET, OF WAUKEGAN, ASSIGNOR TO CHARLES DICKINSON, OF CHICAGO, ILLINOIS.

APPARATUS FOR REPRODUCING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 539,212, dated May 14, 1895.

Application filed January 9, 1895. Serial No. 534,320. (No model.)

To all whom it may concern:

Be it known that I, EDWARD H. AMET, a citizen of the United States, residing in Waukegan, in the county of Lake and State of Illinois, have invented a new and useful Improvement in Apparatus for Reproducing Phonograms, of which the following is a specification.

My invention relates to the copying or reproduction of phonograms or sound writings.

My invention consists in the novel construction of parts and devices and novel combinations of parts and devices herein shown and described and specified in the claims.

In the accompanying drawings, forming a part of this specification, Figure 1 is a plan view of an apparatus suitable for use in practicing my invention and embodying the machine or apparatus features of my invention. Fig. 2 is an enlarged vertical cross-section taken on line 2 2 of Fig. 1, and Fig. 3 shows a modification.

In the drawings A represents the frame and B and B′ the revolving shafts or holders for holding and revolving synchronously the original phonogram cylinder C and the similar cylinder C′ upon which the copy is to be made.

D is the traveling head, frame or slide, upon which the reproducing or following stylus F and the recording or engraving stylus H are mounted. The reproducing stylus F is, or should be, of the usual round pointed jewel-form, and it is secured to a two-way, thin, light flexible spring f, preferably of steel. This spring f is made two-way for the purpose of giving the stylus F the necessary freedom of movement laterally to follow the lines of writing on the cylinder C and also the necessary freedom of movement up and down to follow the elevations and depressions of the sound writing on said cylinder. The spring f can be most conveniently made flexible in two directions by simply giving it a twist f'. By making the spring arm f thus capable of yielding in two directions I obviate the necessity and expense of pivotally mounting said arm upon its support d.

To give opportunity for easily adjusting the direction and position of the reproducing stylus F in relation to the cylinder C I preferably provide the spring arm f with an extension f^2 of copper or other pliable and little resilient material. This makes a means for adjustment of the position and direction of the stylus, which is not only lighter and cheaper but more convenient than adjusting screws or other means.

The recording or engraving stylus H is preferably of the usual sharp pointed jewel construction familiar to those skilled in the art, and it is carried by a lever h which is pivoted at h' to a weight or weighted arm h^2, which itself is pivoted at h^3 to the head D. At the free end of the weighted arm h^2 is an adjustable stop h^4 to limit the movement of the weighted arm. The end of the lever h opposite to the stylus H is connected by a flexible link h^5 to the stylus F; this being done preferably through an intermediate lever h^6 pivoted at h^7 to an arm d^4 on the head D, and which lever h^6 is connected by a link h^8 with the stylus F, or its supporting arm. As shown in Fig. 2 the intermediate lever also serves to multiply the movement, thus tending to make the copy of greater clearness and volume than the original. In the modification shown at Fig. 3 the intermediate lever h^6 is omitted and the link connection made direct between the arm of the reproducing stylus and the lever or arm carrying the recording stylus.

The link connection between the reproducing stylus and the recording stylus, whether the same be made in one piece, as indicated in Fig. 3, or in two pieces h^5 h^8, as indicated in Fig. 2, is preferably made, I find, of lead wire, or other substance possessing little elasticity, though it may be made of any suitable material.

The two shafts B and B′ are revolved synchronously by a belt b on the pulleys b' b^2. The traveling head, slide or frame D is fed or reciprocated by a feeding screw b^3 on the shaft B engaging a screw threaded arm or nut d^5 secured to the head D.

It will be observed that the end of the recording stylus lever h to which the link h^6 is connected, moves directly in unison with the reproducing stylus F, while the recording stylus H on the opposite end of this lever moves reversely in unison with the reproducing stylus F, so that a depression on the cylinder C forms a corresponding depression on the cylinder C′, and in like manner an elevation on the cylinder C forms a corresponding elevation on the cylinder C′; thus making the cylinder C′ a direct instead of a reverse copy of the cylinder C, and, as the connection between the reproducing stylus F and the recording stylus H is direct or mechanical, without the intervention of vibrating diaphragms or sound waves in the air, the copy C′ is necessarily an exact and perfect copy of the original C.

The spring arm f serves to hold the reproducing stylus F properly in contact with the original phonogram cylinder C, and the weighted arm h^2 serves to keep the recording stylus H properly in contact with its cylinder and the link connection between the two styli taut or under tension, so that the movement of the stylus F is properly communicated to the stylus H.

I claim—

1. The combination with revolving shafts B B′ for holding and revolving the cylinders C C′, of a traveling head D, reproducing stylus F secured to a spring arm, recording stylus H secured at one end of a lever h, said lever h, a weighted arm h^2 to which said lever h is pivoted, and a link connection between the opposite end of said lever h and said reproducing stylus, said reproducing stylus carrying spring arm f, being a spring flexible in two directions, substantially as specified.

2. The combination with revolving shafts B B′ for holding and revolving the cylinders C C′, of a traveling head D, reproducing stylus F secured to a spring arm, recording stylus H secured at one end of a lever h, said lever h, a weighted arm h^2 to which said lever h is pivoted, and a link connection between the opposite end of said lever h and said reproducing stylus, said reproducing stylus carrying spring arm f having an extension f^2 of flexible, non-resilient material, substantially as specified.

3. The combination with revolving shafts B B′ for holding and revolving the cylinders C C′, of a traveling head D, reproducing stylus F secured to a spring arm, recording stylus H secured at one end of a lever h, said lever h, a weighted arm h^2 to which said lever h is pivoted, and a link connection between the opposite end of said lever h and said reproducing stylus, and an intermediate lever h^6 inserted in the connection between said lever h and said stylus F, substantially as specified.

4. In a phonogram reproducing or copying mechanism, the combination with a reproducing stylus mounted on a spring arm, of a recording stylus mounted on a weighted arm, and a connection between said spring arm and said weighted arm, said connection being provided with a lever for multiplying the movement, substantially as specified.

5. In a phonogram reproducing or copying mechanism, the combination with a reproducing stylus mounted on a two-way spring arm, of a recording stylus mounted on a weighted lever and a connection between said lever and said spring arm, substantially as specified.

6. In a phonogram reproducing or copying mechanism, the combination with a reproducing stylus mounted on a spring arm, of a recording stylus mounted on a weighted arm, and a lead wire connection between said spring arm and said weighted arm, substantially as specified.

EDWARD H. AMET.

Witnesses:
H. M. MUNDAY,
L. E. CURTIS.

(No Model.)

E. H. AMET.

APPARATUS FOR REPRODUCING PHONOGRAMS.

No. 545,439. Patented Sept. 3, 1895.

FIG. I.

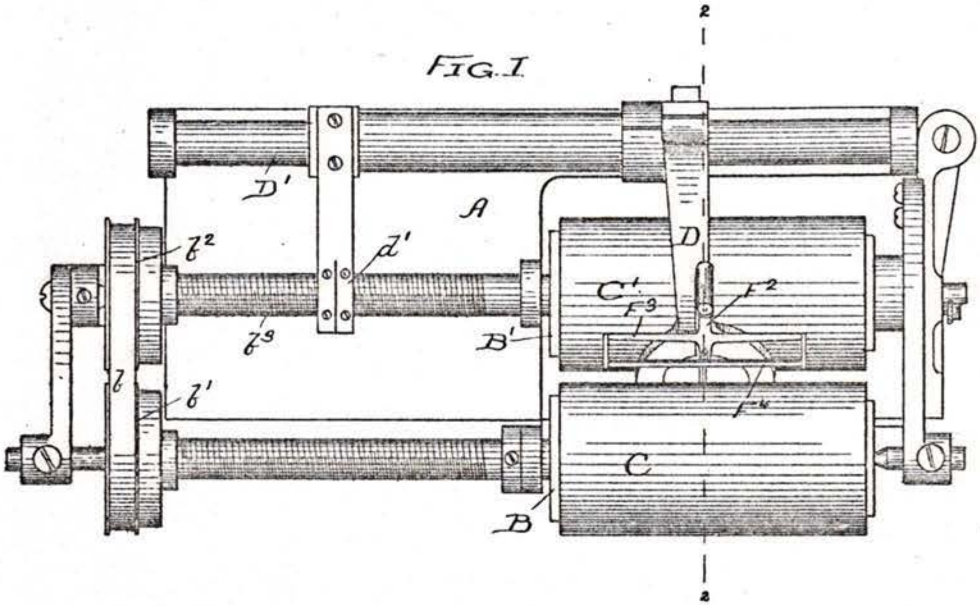

2
D'
A
D
b²
d'
C'
F³
F²
B'
b³
b
b'
F⁴
C
B
2

FIG. 2.

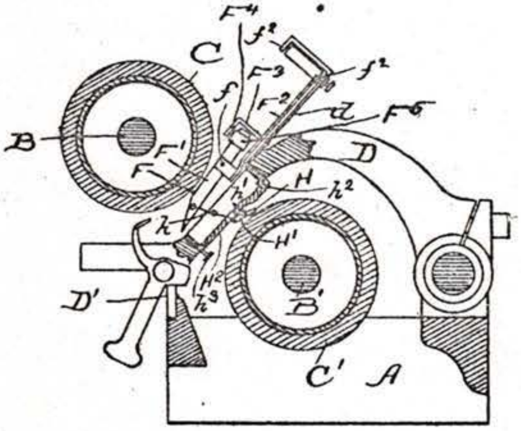
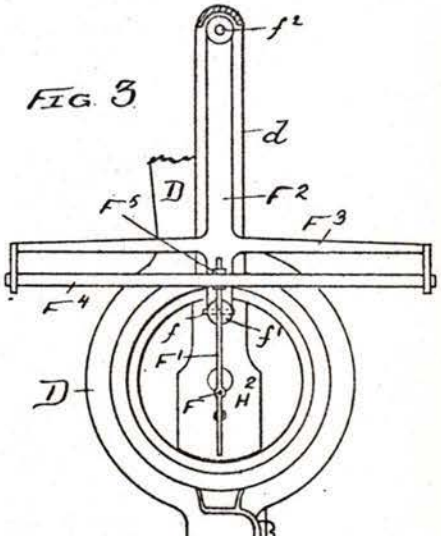

F⁴
f²
f²
C
F³
f
F²
d
F⁶
B
D
F'
F
h'
H
h²
h
H'
D'
H²
h³
B'
C'
A

FIG. 3.


f²
d
D
F⁵
F²
F³
F⁴
f
f'
F'
D
F
H²

WITNESSES:

Lew. C. Curtis

H.W. Munday.

INVENTOR:

EDWARD H. AMET

BY Munday, Evarts & Adcock.

HIS ATTORNEYS.

UNITED STATES PATENT OFFICE.

EDWARD H. AMET, OF WAUKEGAN, ASSIGNOR TO CHARLES DICKINSON,
OF CHICAGO, ILLINOIS.

APPARATUS FOR REPRODUCING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No. 545,439, dated September 3, 1895.

Application filed June 7, 1895. Serial No. 551,984. (No model.)

To all whom it may concern:

Be it known that I, EDWARD H. AMET, a citizen of the United States, residing in Waukegan, in the county of Lake and State of Illinois, have invented a new and useful Improvement in Apparatus for Reproducing Phonograms, of which the following is a specification.

My invention relates to machines for copying or reproducing phonogram or sound writings on wax or other cylinders.

The object of my invention is to provide a machine of a simple and durable construction by means of which phonograms on wax or other cylinders may be accurately and perfectly reproduced on other like cylinders and without any disagreeable modifications in sound or tone due to the action of the mechanism.

In my invention the reproducing or following stylus is secured to or carried by a lever having a direct link or mechanical connection with the lever carrying the recording or engraving stylus, and a light flexible diaphragm-like-acting spring is employed to press against the opposite end of the lever carrying the reproducing or following stylus, and a rubber cushion is inserted between the lever and this flat spring, by which means I find that the engraving-stylus is caused to copy or reproduce very accurately and perfectly the original phonogram, so that the copy cannot be distinguished from the original when placed in a graphophone.

My invention consists in the novel construction of parts and devices and in the novel combinations of parts and devices herein shown and described and specified in the claims.

In the accompanying drawings, forming part of this specification, Figure 1 is a plan view of a machine embodying my invention. Fig. 2 is a section on line 2 2 of Fig. 1. Fig. 3 is a detail plan view of the mechanism carrying and connecting the reproducing-stylus and the engraving-stylus.

Similar letters of reference indicate like parts in all the figures of the drawings.

In the drawings, A represents the frame of the machine; B and B′, the revolving shafts or holders for holding and revolving synchronously the original phonogram-cylinder C and the similar cylinder C′, upon which the copy is to be made.

D is the traveling head frame or slide, upon which the reproducing or following stylus F and the recording or engraving stylus H are both mounted and carried from end to end of the two cylinders.

The reproducing or following stylus F is secured to a vertically or radially vibrating lever F′, which is pivoted at *f* to a stud *f*′, secured to a laterally-vibrating lever F^2, that is pivoted, by pivot-bearings $f f^2 f^2$, to an arm *d*, attached to the traveling frame or slide D. Attached to the laterally-vibrating lever F^2 is a yoke F^3, between the arms of which extends a flat diaphragm-like-acting spring F^4, that bears against the outer or free end of the stylus-carrying lever F′. Interposed between this spring F^4 and the stylus-lever F′ is a rubber or elastic cushion F^5, which serves to prevent or to aid in preventing the communication of any harsh strident or disagreeable action to the engraving-stylus H. The flat spring F^4 has a bearing at each end against the yoke F^3 and presses at its middle against the stylus-lever F′. It thus serves not only to hold the stylus yieldingly against the phonogram-cylinder C, but by reason of its diaphragm-like form and action causes the lever F′ to very faithfully copy the movement and action of the stylus-carrying lever of a phonograph, and as the movement and action of this stylus-carrying lever F′ are communicated to the lever H′, carrying the engraving-stylus H, a very accurate and perfect copy is produced upon the cylinder C′. The stylus F′ is connected to the engraving-stylus lever H′ by a link or links *h*, preferably of wire. The lever H′ is pivoted at *h*′ to a pivoted arm H^2, which itself is pivoted at h^2 to the traveling frame or slide D. At the free end of the pivoted arm or lever H^2 is an adjustable stop h^3 to limit the movement of said arm H^2.

The two shafts B B′ are rotated synchronously by a belt *b* on the pulleys *b*′ b^2. The traveling frame or slide D is fed or reciprocated by a feeding-screw b^3 on the shaft B′ engaging a threaded nut or arm *d*′, secured to the head or frame D. The frame or slide D travels back and forth on a suitable guide D′. The spring F^4 is soldered or secured rigidly at one end to one arm of the yoke F^3 and simply pressed against the other arm of the yoke without being secured or attached thereto.

I claim—

1. In a machine for copying and reproducing phonograms, the combination with a reproducing stylus secured to a vertically vibrating lever, a laterally vibrating lever upon which said first mentioned lever is mounted, a yoke on said laterally vibrating lever, a spring extending between and bearing against the arms of said yoke and also against said stylus carrying lever, substantially as specified.

2. In a machine for copying and reproducing phonograms, the combination with a reproducing stylus secured to a vertically vibrating lever, a laterally vibrating lever upon which said first mentioned lever is mounted, a yoke on said laterally vibrating lever, a spring extending between and bearing against the arms of said yoke and also against said stylus carrying lever, and a cushion between said spring and stylus carrying lever, substantially as specified.

3. In a machine for copying and reproducing phonograms, the combination with a reproducing stylus secured to a vertically vibrating lever, a laterally vibrating lever upon which said first mentioned lever is mounted, a yoke on said laterally vibrating lever, a spring extending between and bearing against the arms of said yoke and also against said stylus carrying lever, an engraving stylus, a lever carrying the same and means for connecting said engraving stylus carrying lever with said reproducing stylus carrying lever, substantially as specified.

4. In a machine for copying and reproducing phonograms, the combination with a reproducing stylus secured to a vertically vibrating lever, a laterally vibrating lever upon which said first mentioned lever is mounted, a yoke on said laterally vibrating lever, a spring extending between and bearing against the arms of said yoke and also against said stylus carrying lever, and a cushion between said spring and stylus carrying lever, an engraving stylus, a lever carrying the same and means for connecting said engraving stylus carrying lever with said reproducing stylus carrying lever, substantially as specified.

5. In a machine for copying or reproducing phonograms, the combination with a reproducing stylus F, a lever F' on which it is mounted, a flat spring F^4 supported at both ends and bearing at its middle against said lever F', an engraving stylus H, a lever H' on which it is mounted, and a connection between said levers F' and H' substantially as specified.

6. In a machine for copying or reproducing phonograms, the combination with a reproducing stylus F, a lever F' on which it is mounted, a flat spring F^4 supported at both ends and bearing at its middle against said lever F', an engraving stylus H, a lever H' on which it is mounted, and a connection between said levers F' and H', and a rubber cushion F^5 between said lever F' and spring F^4, substantially as specified.

EDWARD H. AMET.

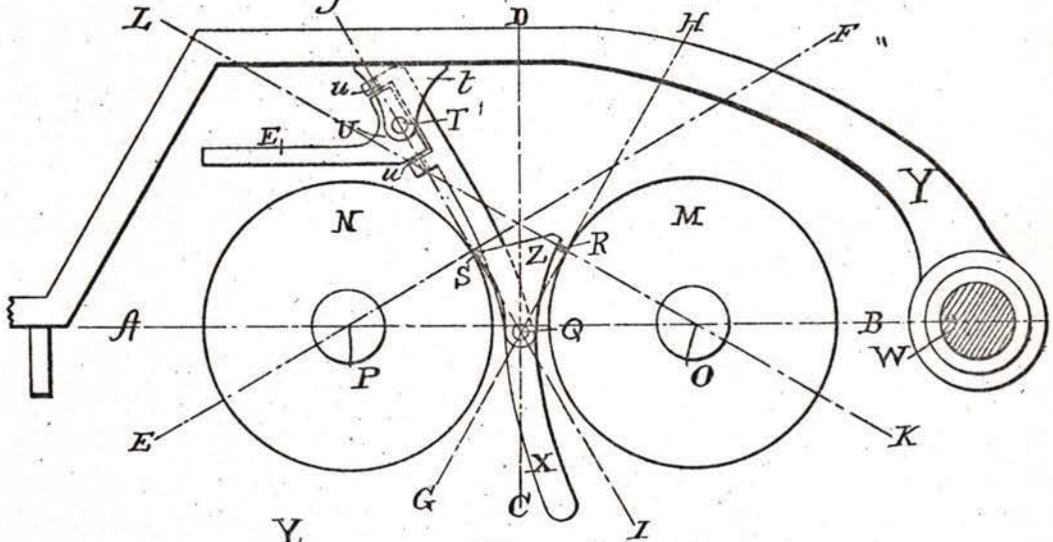
Witnesses:
EDMUND ADCOCK,
H. M. MUNDAY.

(No Model.)

T. H. MACDONALD.

DEVICE OR APPARATUS FOR DUPLICATING GRAPHOPHONE RECORDS.

No. 559,806. Patented May 12, 1896.


L
J
D
H
F
u
t
T'
U
E1
u
N
M
Y
Z
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S
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Q
B
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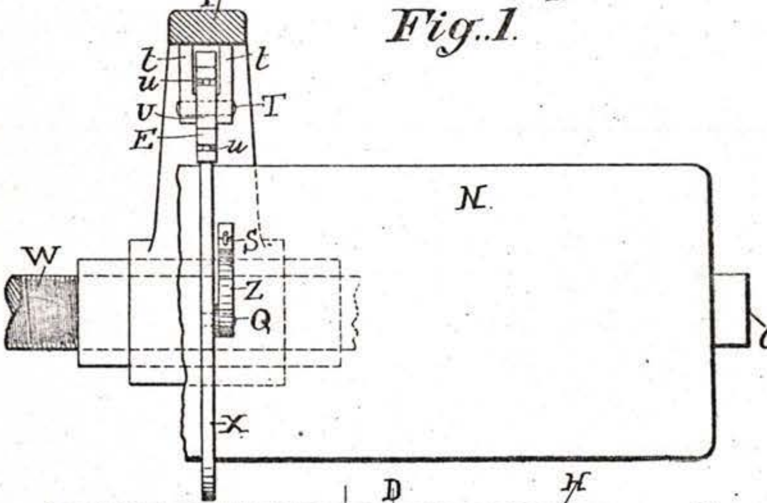
P
O
E
K
X
G
C
I

Fig. 1.


Y
t
t
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U
T
E
u
N.
S
W
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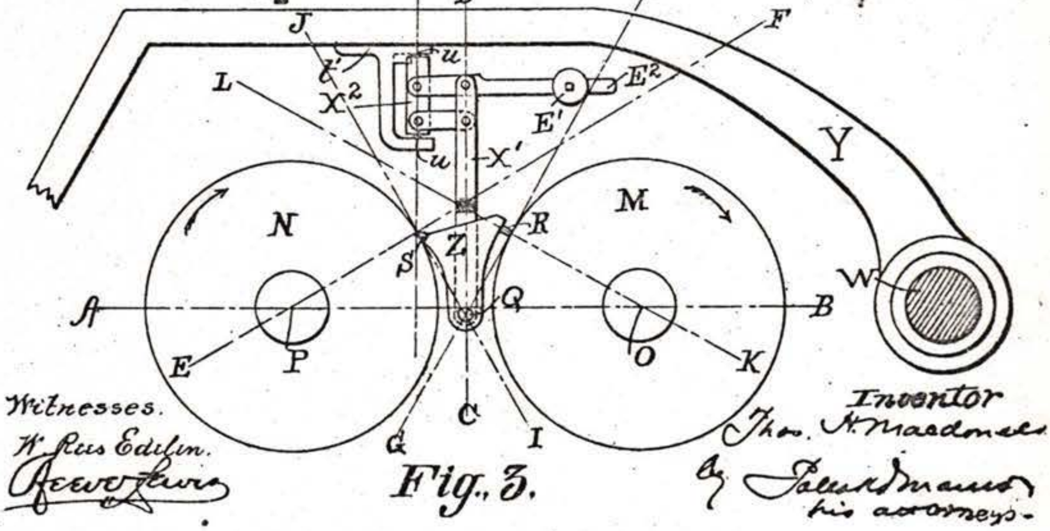
Q
O
X

Fig 2.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u
X'
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W
A
Q
B
E
P
O
K
C
G
I

Fig. 3.

Witnesses.
W. Rees Edelin.

Inventor
Thos. H. Macdonald
By Pollok & Mauro
his attorneys.

UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WEST VIRGINIA.

DEVICE OR APPARATUS FOR DUPLICATING GRAPHOPHONE-RECORDS.

SPECIFICATION forming part of Letters Patent No. 559,806, dated May 12, 1896.

Application filed December 4, 1895. Serial No. 571,083. (No model.)

To all whom it may concern:

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Connecticut, have invented a new and useful Improvement in Devices or Apparatus for Duplicating Graphophone-Records, which is fully set forth in the following specification.

This invention has reference to devices or apparatus for duplicating graphophonic records. In such apparatus as heretofore constructed the reproducing and recording styles have usually been carried by separate levers connected by suitable intermediate links, diaphragms, &c., the pressure requisite to cut the duplicate record being transmitted through the pivot-points of the levers by suitable weights or other equivalent means. Such devices not only require very painstaking adjustment, but owing to their delicacy of structure are very susceptible to injury.

The object of my present invention is to provide a much simplified construction of a substantial character and which will duplicate records with greater precision than the duplicating devices heretofore in use. In accordance therewith the reproducing and recording styles are rigidly connected, both being carried by a lever to which vibratory movements are imparted by the master record and whereby the reproducing-style is caused to cut in a blank a duplicate corresponding to the master record. This lever is pivoted to an arm, which is arranged (at an inclination or otherwise) so that the weight thereof falls upon the point of pivot to hold the styles in contact with their respective cylinders. Said arm, which may for distinction be called the "pressure-arm," is pivoted at one end to swing therefrom and is also swiveled, permitting movement about a longitudinal axis. The pressure exerted by the pressure-arm may and is preferably counteracted to some extent by a weight operating from the pivot-point of said arm, thus permitting the latter to be made much heavier and more substantial and giving it greater inertia than would otherwise be permissible with a device of this general construction. As the blank cylinder revolves against the cutting-point of the recorder a groove is cut in its surface exactly corresponding to that of the master record, the reproducing-point following and accurately transmitting to the recorder the movements due to variations in the depth of cut of the master record. The recording-point is in the line of the axis on which the pressure-arm is swiveled longitudinally, so that the reproducing-point can find its adjustment accurately without disturbing the position of the recorder.

Details of arrangement and what is considered the best embodiment of my invention in an operative machine will be clearly understood by reference to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a cross-section of an apparatus embodying the invention; Fig. 2, an elevation, partly in section; and Fig. 3, a view similar to Fig. 1, illustrating another form of apparatus embodying the invention.

Referring to Figs. 1 and 2, Y represents a traveling supporting-arm engaging a feed-screw W at one end and sliding on a rail V at its other end. M is the master-record cylinder, and N the blank cylinder for receiving the duplicate, said cylinders being horizontally arranged parallel to each other and carried by suitable mandrels connected with and driven at the same speed by suitable mechanism in a well-known manner. Z is a lever carrying the reproducing-point R and the recording-point S. This lever is pivoted at Q to pressure-lever X, arranged at an inclination and swiveled upon the pins *u u*, projecting into sockets in a block U to turn about a longitudinal axis. The block U, carrying a weighted arm E, counteracting to some extent the pressure exerted by the lever X upon the points R and S, is pivoted at T to a bifurcated bracket *t*, depending from the arm Y. The weighted lever or pressure-arm X is thus pivoted at T to swing in a plane at right angles to the axis of the record-cylinders and on the points *u* to oscillate slightly on an axis tangent to cylinder N.

To state with geometrical precision that relation and arrangement of the parts which has in actual practice been found to produce the best results, but to which the invention is not limited, it is preferable to locate the pivot-point Q of lever Z at the intersection of two corresponding tangent lines I J and G H, said point of intersection being near a horizontal line A B, projected through the axes O and P of the cylinders M and N, while the recording and reproducing points S and R bear against the cylinders at the respective tangent points of the said lines I J and G H. The swivel-pins *u u* are also in the tangent line I J in which the recording-point is located, so that the oscillating movement of the arm X is about the line I J as an axis. Consequently the reproducing-point R can find a lateral adjustment without affecting the position of the recording-point S. It will be noted that the pivot-points T and Q and the swivel-points *u u* are all in line with the recording-point S, the object of this disposition being to prevent distortion.

From the foregoing description it will be understood that the weight of arm X, swinging from pivot-point T and acting upon fulcrum Q of lever Z, supplies the pressure in the direction of line C D for holding the points R and S in contact with the cylinders M and N, which pressure it is found desirable for the reasons indicated to counteract to some extent by the weight E. Thus as the cylinders rotate in the direction of the arrows the variations in depth of the master record cause the point R to move in the direction of the radial line L K of cylinder M, vibrating the lever Z on the pivot Q, and in turn imparting movements to the point S in the direction of the radial line E F of cylinder N, and thereby causing it to cut a record in the blank N exactly corresponding to the master record.

Referring now to Fig. 3, the lever or support Z for the recording and reproducing points is, as before, pivoted at Q to a pressure-arm X', the point Q being at the intersection of the two tangent-lines I J and G H, drawn from the respective points of contact of the recorder and reproducer with cylinders M N. Arm or lever X' is depressed by the counterweight E', adjustable on lever E^2. In order to secure parallelism of movement of lever X', it is made part of a pantograph system, the parallel arm X^2 being swiveled at points *u u* in the bracket t', so as to permit a slight oscillation, as in the arrangement shown in Fig. 1. This axis of oscillation is in a line which intersects recording-point S. The operation of the apparatus shown in Fig. 3 is substantially as already described with reference to Figs. 1 and 2.

The disposition and arrangement of the several parts have been described with minuteness of detail for the purpose of exhibiting the invention in the best practical forms known to me.

It will be obvious to skilled mechanics that these details may be varied within wide limits without departing from the spirit of the invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A device for duplicating graphophone-records comprising, in combination, a lever mounted to vibrate between a master record and a blank, a reproducing and a recording style carried by said lever, and means for applying pressure to the lever whereby said styles are respectively maintained in contact with the master record and blank, substantially as described.

2. A duplicating apparatus comprising, in combination, a support mounted to vibrate between a master record and a blank, a reproducing and a recording style secured rigidly to said support, and a pivoted pressure-arm carrying the fulcrum of the support and holding the styles with yielding pressure respectively in contact with the master record and blank, substantially as described.

3. In a graphophonic duplicating device, the combination with a suitable support, of a lever carrying the reproducing and recording styles, said lever being mounted to have a vibratory movement between a master record and a blank, and an oscillatory movement on an axis intersecting the point of the recording-style, substantially as described.

4. In a duplicating device, the combination with a supporting-arm, of a lever carrying the reproducing and recording styles and mounted to vibrate between the master record and blank, a pressure-arm pivotally supported from said supporting-arm, carrying the fulcrum of said lever, and swiveled to oscillate slightly about a longitudinal axis, substantially as described.

5. A duplicating apparatus comprising in combination a lever carrying the reproducing and recording styles, and mounted to vibrate between the master record and blank, and a pivotally-supported weighted arm carrying the fulcrum of the lever and swiveled to oscillate about a longitudinal axis passing through the recording-style and the fulcrum of the lever, substantially as described.

6. In a duplicating apparatus, the combination of a lever carrying the reproducing and the recording styles and mounted to vibrate between the master record and blank, a pivoted weighted arm carrying the fulcrum of said lever, and means for partially counteracting the weight of said arm, substantially as described.

7. In a duplicating apparatus, the combination with a supporting-arm, of a pivoted lever carrying the reproducing and recording styles and mounted to vibrate between the master record and the blank, a block pivotally connected to said supporting-arm, a weighted pressure-arm swiveled to said block and carrying the pivot of the lever, and a weighted arm on the block acting to partially counteract the pressure of the arm, substantially as described.

8. In a duplicating apparatus, the combination of the weighted pressure-arm, a lever fulcrumed thereon between the master record and blank, a reproducing-point and a record-

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ing-point pressed by the weight of said arm into contact with the said master record and blank, respectively, the fulcrum of said lever being at the intersection of tangent lines drawn respectively from the points of the recorder and reproducer, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
G. L. HUBBELL,
CLEMENT MARCH.

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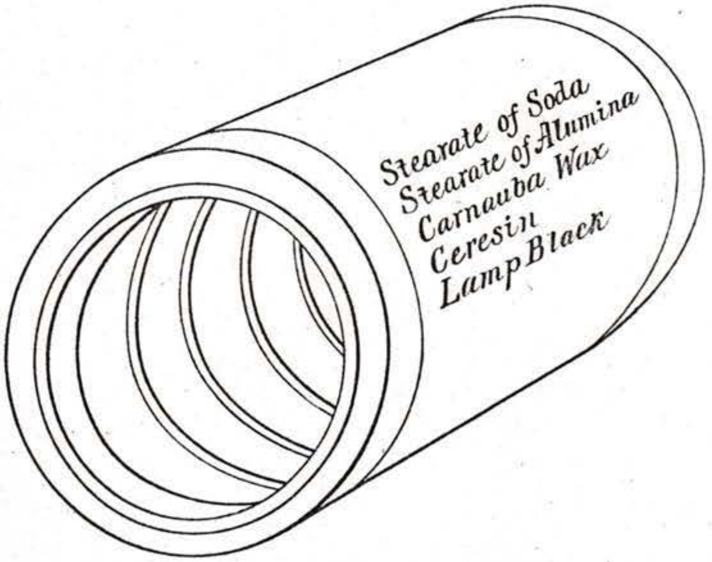
No. 782,375. PATENTED FEB. 14, 1905.

J. W. AYLSWORTH.

COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH RECORDS.

APPLICATION FILED NOV. 3, 1903.


Stearate of Soda
Stearate of Alumina
Carnauba Wax
Ceresin
Lamp Black

Attest:
Edgeworth Greene
Delos Holden

Inventor:
Jonas W. Aylsworth
by Frank L. Dyer
Atty.

No. 782,375. **Patented February 14, 1905.**

UNITED STATES PATENT OFFICE.

JONAS W. AYLSWORTH, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO NEW JERSEY PATENT COMPANY, OF ORANGE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

COMPOSITION FOR MAKING DUPLICATE PHONOGRAPH-RECORDS.

SPECIFICATION forming part of Letters Patent No. 782,375, dated February 14, 1905.

Application filed November 3, 1903. Serial No. 179,729.

To all whom it may concern:

Be it known that I, Jonas W. Aylsworth, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Compositions for Making Duplicate Phonograph-Records, of which the following is a description.

My invention relates to a new composition adapted particularly for making duplicate phonograph-records obtained by any suitable process from a matrix or mold; but the composition has been gotten up especially for making duplicate phonograph-records obtained by the process described in patent to Miller and Aylsworth, No. 683,615, dated October 1, 1901, and wherein a suitable mold carrying on its bore the negative representation of the record to be duplicated is immersed in a molten wax-like coagulable material, which forms a coagulated layer of the desired thickness on the bore of the mold, after which the material is reamed out internally while warm and the resulting duplicate removed by shrinking diametrically and removing the same longitudinally from the mold, its ends being finally finished. The desirable properties or characteristics of my improved composition are such, however, that it may be effectively utilized for the manufacture of duplicate phonograph-records obtained by means of any process wherein material in a molten or plastic condition is introduced into a matrix or mold and is allowed to set or is expanded therein so as to take an impression, being removed by diametric shrinkage sufficient to clear the engaging surfaces.

A composition suitable for the purpose should have certain peculiarities, which I have been able to secure only after long experiment. In the first place, the composition should be very limpid when in a molten or plastic state, so as to flow into intimate engagement or contact with the record-surface, and thereby permit a very sharp impression to be received. It should be free of decomposition products, which would otherwise result in the generation of gas, forming bubbles, which would destroy the commercial character of the record-surface. It should be of excessively-fine texture or grain, so as not to produce extraneous sounds when the reproducer rubs over it. It should be very hard when set, so as to reduce wear as much as possible, due to the tracking of the reproducer. It should have the capacity of passing from the liquid to the solid state through an intermediate condition of gradually-reduced plasticity, to thereby enable the duplicate to shrink internally and toward the surface, so as not to clear the mold until quite hard, to thereby preserve the record, instead of chilling very rapidly at the surface to form a relatively hard film, which tends to shrink away from the mold even when the mass of the material is still molten, since I find that materials having this latter characteristic are not suitable for the purpose, owing to the danger of the record-surface being injured under the effect of the unequal chilling. It should not be sticky or tenacious, so as to adhere to the mold when set, even to the smallest extent. It should be capable of shrinking away from the mold when quite hard by a reduction in its temperature. It should have a very smooth and polished surface, so as to eliminate foreign noises due to the tracking of the reproducer. It should be free from air and gas bubbles, which if present at the surface would destroy the commercial character of any duplicates containing them. It should shrink uniformly without warping, so as to be capable of effective use with standard talking-machines. It should not be affected by moisture, so as to be preserved in damp climates; and it should have a high melting-point, so as not to soften in hot localities. When hot, it should be capable of being cleanly cut in reaming without dragging or chipping, so as to present a smooth clean surface on the bore of the duplicate. Preferably it should be of a very dark color to permit imperfections to be better observed. It should be perfectly amorphous and non-crystalline, since the latter materials harden very quickly at the surface when their congealing temperature is reached and shrink irregularly, with the objections pointed out. The composition which I have invented and which will be herein described is one possessing these characteristics, and hence is especially adapted for use in this art.

In describing my improved composition and the process which I prefer to follow in compounding the same I shall refer to preferable proportions of ingredients, to preferable steps or procedures in the process, and to preferable temperatures, all based on actual practical experience in this art; but it will be understood that in these respects considerable variations may be made, as will be obvious to those skilled in the art.

Reference is hereby made to the accompanying drawing, which shows in perspective a phonograph-record having inscribed thereon the names of ingredients which are preferably used in the preparation of my invention.

In making my improved composition I prefer to proceed, therefore, substantially as follows:

I first take one hundred pounds of commercial stearic acid, which, as is known, is generally a mixture of stearic and palmitic acids, and melt the same in a suitable galvanized-iron caldron or other vessel at a temperature of about 240° Fahrenheit. The stearic acid used melts at about 136° Fahrenheit. Care should be taken to see that the stearic acid is substantially free from oleic acid, as well as from mineral acids, salts, glycerin, and undecomposed fats, as tallow, &c. It should also be free from mucilaginous substances and hydrocarbons. When the stearic acid is fully melted, I then add to the same a water solution of carbonate of soda and aluminate of soda, obtained, preferably, in the following way: I first dissolve twenty-one and a half pounds of recrystallized sodium carbonate, in a suitable steam-jacketed caldron of about twenty gallons capacity, in ten gallons of water, and I add to the solution four hundred and fifty-two grams of caustic soda of the best grade of the commercial article. When all is dissolved, I add one hundred and seventy-five grams of metallic aluminium, preferably in the form of pieces about three inches by twelve inches square and twenty one-thousandths of an inch in thickness. When the metal is added to the solution, I turn off the heat and allow the metal to dissolve, which takes place inside of three hours. When all the metal is dissolved, the solution is filtered while still hot in a filter-press or in any other way. In adding the alkaline solution to the melted stearic acid I gradually raise the temperature of the latter so as to correspond with the increased melting-point of the mixture. The alkaline solution is added as rapidly as possible without unduly running the temperature down or causing excessive boiling or foaming. The solution can be added quite rapidly at first; but toward the end it must be added very slowly. The addition of the alkaline solution to the stearic acid results in the production of stearates and palmitates of soda and of aluminium, the latter being metallic soaps or metallic salts of fatty acids. During the saponification which thus takes place water is driven off. At the end of the operation the temperature will have gradually run up to about 360° Fahrenheit. I now add to the molten metallic-soap mixture twenty-one and thirty-six hundredths pounds of a very hard wax, preferably carnauba, the latter consisting of a mixture or combination of the higher fatty acids and alcohols. The carnauba-wax used should be as clean as possible, and it may be purified by melting the same with an equal weight of water, heating by a jet of direct steam and boiling for a short time, then drawing off or evaporating the water, after which it may be poured into pans, where it is allowed to cool into cakes suitable for weighing. When the carnauba-wax is added to the soap mixture, the temperature of the mass is raised to about 450° Fahrenheit and maintained until all foaming ceases, which usually takes about five hours. By thus subjecting the mixture to a relatively high heat a combination is effected between the alcohols of the carnauba-wax and the excessive stearic acid present in the metallic-soap composition, forming a hard wax-like compound ether, which gives to the composition many of its desirable characteristics. Unless the carnauba-wax is heated materially beyond its melting-point, resulting in the reaction referred to taking place, the composition, although harder, is very brittle and shrinks excessively and is therefore not so desirable as when the high heating is effected. Furthermore, unless this is done there is greater likelihood of decomposable products remaining in the composition, affecting the character thereof and resulting in the production of bubbles in the surface of the resulting duplicate.

After the treatment of the molten material at a high temperature has been effected and all foaming has ceased I add twenty-one and thirty-six hundredths pounds of ceresin thereto, although other hydrocarbon waxes may be employed, such as paraffin or ozocerite. The purpose of this latter ingredient is to make the mixture non-hygroscopic and also less brittle than it otherwise would be. When ceresin is used, its melting-point should be, preferably, about 145° Fahrenheit, and in any event as high as can be obtained, and it should present a fine grain on fracture and should be free from paraffin.

For the purpose of darkly coloring the composition a suitable amount of fine pure lampblack—say from .9 per cent. to three per cent. thereof—or other suitable inert finely-pulverized pigment may be added to the molten mass at any stage of the operation. Preferably, however, the coloring-matter is added together with the carnauba-wax.

After the ceresin is added and thoroughly incorporated with the mixture the congealing temperature of the latter may be regulated by adding free stearic acid thereto. In using the process described in the patent to Miller and Aylsworth, before referred to, I prefer to adjust the congealing-point of the mixture at about 290° Fahrenheit, since excellent commercial results have been secured at that temperature. I find that in dealing with temperatures above 290° Fahrenheit the addition of one per cent., by weight, of stearic acid effects a drop of about 5° Fahrenheit in the congealing-point. Obviously this regulation of the congealing-point of the mixture depends upon the special process which is to be followed in making duplicates, and where the congealing temperature is not important no attention whatever need be paid to its regulation. The material is now strained, preferably through open muslin, and is ready for use.

While I prefer in all cases to make use of caranuba-wax, as described, yet I find that beeswax and Chinese wax and palm-wax all contain alcohols somewhat similar to those of carnauba-wax and by which substantially similar reactions take place. These materials may therefore be substituted for the carnauba-wax, but always at a sacrifice in the desirable condition of the resulting products.

Having now described my invention, what I claim as new therein, and desire to secure by Letters Patent, is as follows:

1. A composition for phonograph recording-surfaces, comprising a metallic soap and a hard wax added thereto, substantially as set forth.

2. A composition for phonograph recording-surfaces, comprising a metallic soap and carnauba-wax added thereto, substantially as set forth.

3. A composition for phonograph recording-surfaces, comprising a mixture of metallic soap, a hard wax and a non-hygroscopic ingredient, substantially as set forth.

4. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax, and ceresin, substantially as set forth.

5. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and a non-hygroscopic ingredient, substantially as set forth.

6. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and ceresin, substantially as set forth.

7. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap and a wax-like compound ether, substantially as set forth.

8. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a non-hygroscopic ingredient, substantially as set forth.

9. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether and ceresin, substantially as set forth.

10. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax and a black pigment, substantially as set forth.

11. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a hard wax and lampblack, substantially as set forth.

12. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and a black pigment, substantially as set forth.

13. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax and lampblack, substantially as set forth.

14. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax, ceresin and a black pigment, substantially as set forth.

15. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, carnauba-wax, ceresin and lampblack, substantially as set forth.

16. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether, and a black pigment, substantially as set forth.

17. A composition for phonograph recording-surfaces, comprising a mixture of a metallic soap, a wax-like compound ether and lampblack, substantially as set forth.

18. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax, and a non-hygroscopic ingredient, substantially as set forth.

19. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax and ceresin, substantially as set forth.

20. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, carnauba-wax and a black pigment, substantially as set forth.

21. A composition for phonograph recording-surfaces, comprising a stearate of soda, carnauba-wax and lampblack, substantially as set forth.

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22. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, and carnauba-wax, substantially as set forth.

23. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, carnauba-wax and lampblack, substantially as set forth.

24. A composition for phonograph recording-surfaces, comprising a mixture of stearate of soda, stearate of alumina, carnauba-wax, ceresin and lampblack, substantially as set forth.

This specification signed and witnessed this 29th day of October, 1903.

JONAS W. AYLSWORTH.

Witnesses:
FRANK L. DYER,
WILLIAM A. DOLAN.

(No Model.)

E. BERLINER.

GRAMOPHONE.

No. 372,786. Patented Nov. 8, 1887.

Fig. 1.

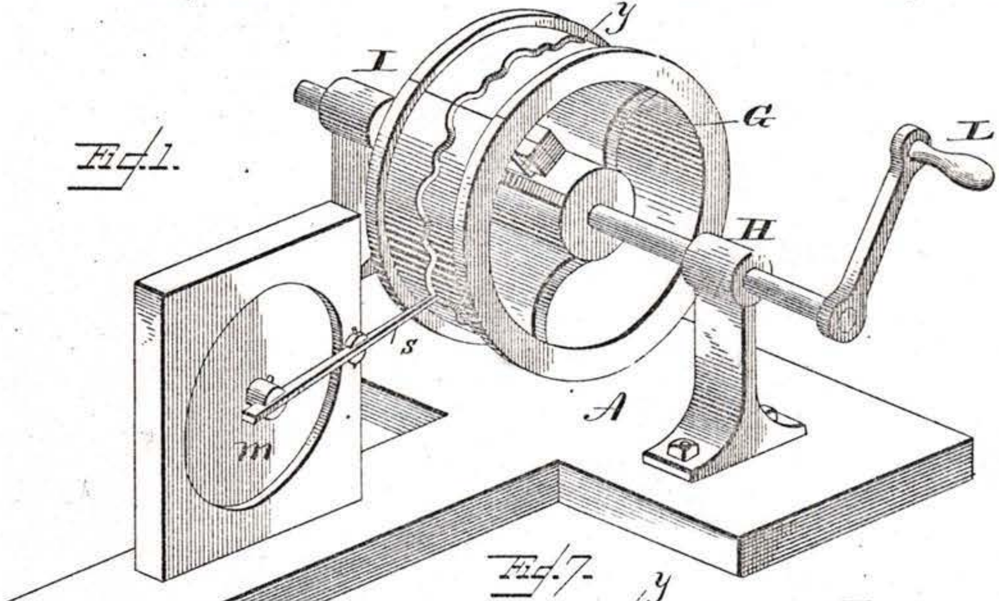

Fig. 7.

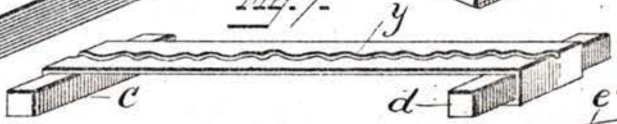

Fig. 3.

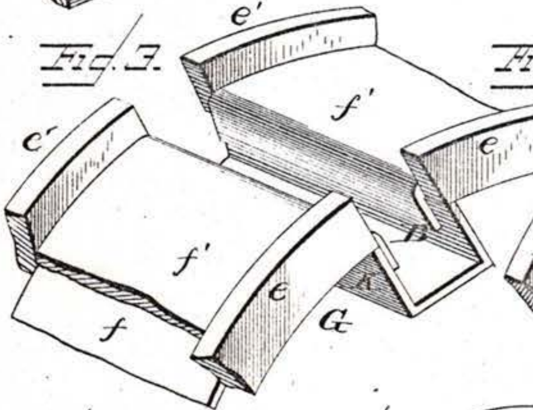

Fig. 4.

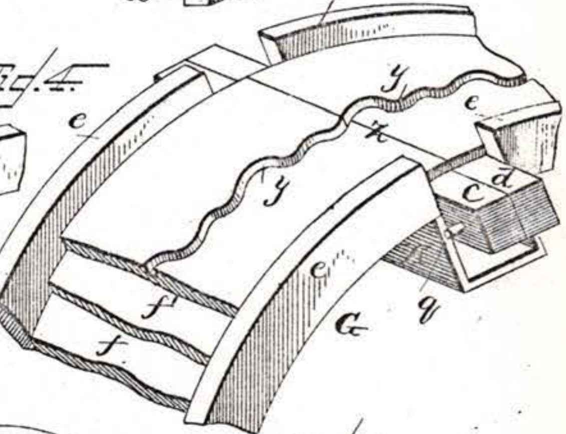
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Fig. 5.

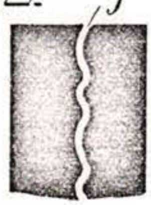


Fig. 2.

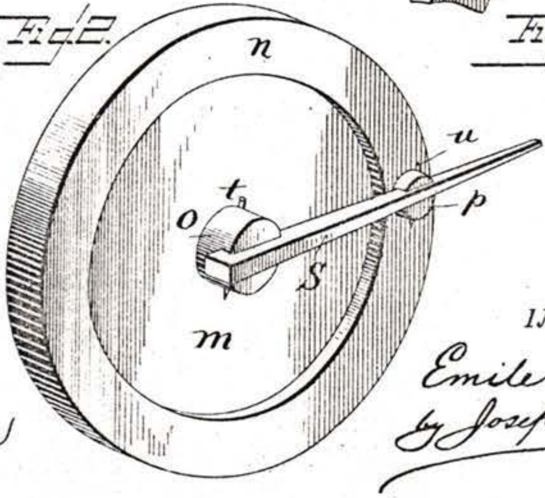
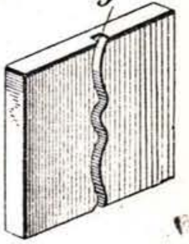


Fig. 6.



WITNESSES

J. H. Coleman

Wm. E. Schoenborn

INVENTOR

Emile Berliner.

by Joseph Lyons

Attorney

UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA.

GRAMOPHONE.

SPECIFICATION forming part of Letters Patent No. 372,786, dated November 8, 1887.

Original application filed May 4, 1887, Serial No. 237,060. Divided and this application filed September 26, 1887. Serial No. 250,721.
(No model.)

To all whom it may concern:

Be it known that I, EMILE BERLINER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Gramophones, of which the following is a specification.

This invention has reference to a novel method of and apparatus for recording and reproducing all kinds of sounds, including spoken words, and is designed to overcome the defects inherent in that art as now practiced and in the apparatus used therefor.

By the ordinary method of recording spoken words or other sounds for reproduction it is attempted to cause a stylus attached to a vibratory diaphragm to indent a traveling sheet of tin-foil or other like substance to a depth varying in accordance with the amplitudes of the sound-waves to be recorded. This attempt is necessarily more or less ineffective, for the reason that the force of a diaphragm vibrating under the impact of sound-waves is very weak, and that in the act of overcoming the resistance of the tin-foil or other material the vibrations of the diaphragm are not only weakened, but are also modified. Thus while the record contains as many undulations as the sounds which produce it, and in the same order of succession, the character of the recorded undulations is more or less different from those of the sounds uttered against the diaphragm. There is, then, a true record of the pitch, but a distorted record of the quality of the sounds obtained. The simple statement that the material upon which the record is made resists the movement of the diaphragm is not sufficient to explain the distortion of the character of the undulations, for if that resistance were uniform, or even proportional to the displacement of the stylus, the record would be simply weakened, but not distorted; but it is a fact that the resistance of any material to indentation increases faster than the depth of indentation, so that a vibration of greater amplitude of the stylus meets with a disproportionately greater resistance than a vibration of smaller amplitude. For this reason loud sounds are even less accurately recorded than faint sounds, and the individual voice of a loud speaker record. and then reproduced by the phonograph cannot be recognized. With a view of overcoming this defect it has been attempted to engrave instead of indent a record of the vibrations of the diaphragm by employing a stylus shaped and operating like a chisel upon a suitably-prepared surface; but even in this case the disturbing causes above referred to are still present. In addition to this, if in the apparatus of the phonograph or graphophone type it is attempted to avoid the disturbing influence of the increase of resistance of the record-surface with the depth of indentation or cut as much as possible by primarily adjusting the stylus so as to touch the record-surface only lightly, then another disturbing influence is brought into existence by the fact that with such adjustment, when the diaphragm moves outwardly, the stylus will leave the record-surface entirely, so that part of each vibration will not be recorded at all. This is more particularly the case when loud sounds are recorded, and it manifests itself in the reproduction, which then yields quite unintelligible sounds.

It is the object of my invention to overcome these difficulties by recording spoken words or other sounds without perceptible friction between the recording-surface and the recording-stylus, and by maintaining the unavoidable friction uniform for all vibrations of the diaphragm. The record thus obtained, almost frictionless, I copy in a solid resisting material by any of the methods hereinafter described, and I employ such copy of the original record for the reproduction of the recorded sounds.

Instead of moving the recording-stylus at right angles to and against the record-surface, I cause the same to move under the influence of sound-waves parallel with and barely in contact with such surface, which latter is covered with a layer of any material that offers a minimum resistance to the action of a stylus operating to displace the same, all substantially in the manner of the well-known phonautograph by Leon Scott. All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, which illustrate one of the numerous forms which my improved apparatus may assume, and in which—

Figure 1 is a perspective view of my recording and reproducing apparatus; Fig. 2, a like view of the recording and reproducing diaphragm with its stylus; Fig. 3, a similar view of a portion of the support for the record-surface; Fig. 4, the same view with the record-surface applied; Fig. 5, a plan view of a phonautographic record; Fig. 6, a perspective of a phonautographic record copied in solid resisting material; and Fig. 7, the copied record mounted, ready for application to the support.

The general arrangement of the parts is best illustrated in Fig. 1, in which a T-shaped base-plate, A, is shown, upon which two standards, H I, serving as journal-bearings for the shaft of drum G, are mounted. The drum G may be constructed with flanges *c c′*, which project beyond the cylinder-surface *f*, and from the edges of a gap, B, left upon the cylinder-surface extend the side walls of box K, as shown. A thin layer of felt or other yielding elastic substance is placed upon the cylinder-surface and is bent over the edges of the gap and secured to the side walls of the box K. This layer of elastic material is designed to serve as the support for the record-surface both in recording and reproducing.

For recording I employ a thin strip of paper, parchment, metal, or any other suitable substance, which is secured at both ends to bars *c d*, in the manner shown in Fig. 7, with reference to a copy of a record, and is then placed upon the elastic support *f′*, with the bars *c d* entering into but projecting at both ends beyond the box K, as illustrated in Figs. 1 and 4, with reference to an engraved copy of a record. Bolts *q*, passing through the projecting ends of bars *c d*, are employed to draw the record-strip tightly about the drum, and the length of the strip is such that the ends of the same meet as nearly as practicable upon a straight line, *z*. The record-sheet is then prepared to receive the record by covering its surface with a thin layer of any substance which is easily removed by the action of the recording-stylus. I may use lamp-black, which is deposited by placing a smoky flame under the record-strip and by slowly turning the drum until all parts of the strip are covered with the deposit. It is well known that a layer of lamp-black thus deposited, while it adheres well to the surface of a solid body, is nevertheless easily removed from the same. It requires only an exceedingly small force to draw a plainly-visible line upon such surface, owing to the fact that the spicules of carbon of which lamp-black is composed are only loosely superimposed upon each other, and are exceedingly light. All this has long since been recognized and utilized in the production of phonautographic records, and I take advantage of these facts in my improved method of recording and reproducing sounds.

The diaphragm *m* is mounted in a frame, *n*, with its plane at right angles to the axis of drum G. A post, O, is fixed to the center of the diaphragm, and a slot in said post receives one end of stylus S, which is pivoted in the post by a pin, *t*. The stylus extends over and beyond the frame, with its free end barely in contact with the record-surface, and is also pivotally supported in a slot in a post, *p*, secured to the frame by means of a pin, *u*, as shown in Figs. 1 and 2. It will now be seen that the stylus is in effect a lever having its fulcrum in the pin *u*, and that its free end can only move in lines practically parallel to the record-surface. If it is now desired to produce a record of sounds the drum is slowly and uniformly rotated by means of crank L, or by any other suitable means, and sounds are uttered or directed against the diaphragm. Under the impact of the sound-waves the diaphragm is set into vibrations, whereby the free end of the stylus is also caused to vibrate to the right and left of its normal position, removing at the same time an undulating line, *y*, of lamp-black from the record-surface, as indicated, greatly exaggerated, in Fig. 5. Since in this operation the stylus only penetrates a uniform layer of loosely-heaped carbon spicules and barely touches the record-surface, it is clear that the slight friction at the free end of the stylus will be uniform, whatever be the amplitude of vibration. Consequently the vibrations of the diaphragm will not be modified or changed by the reaction upon the same of a sensible and varying resistance, as is the case in all other mechanical sound-recorders.

Having thus obtained an accurate phonautographic record, the same may be fixed by applying a thin solution of varnish of any kind which dries very rapidly and which does not obliterate or change the record.

If in this process the deposit of lamp-black be made thick enough, the line drawn by the stylus would represent a groove of even depth, preserving all the characteristics of the sounds which produced it and which may be handled and touched with impunity. The latter is then removed from the drum and may be preserved any length of time without danger of its being disfigured. This record I then copy in solid resisting material, preferably metal, either by the purely mechanical process of engraving, or by chemical deposition, or by photo-engraving. I prefer the last-named process, which enables me to produce the most accurate copy of the original record in copper, nickel, or any other metal without in any way or manner affecting the original record. The copy thus obtained, which may be multiplied to any desired extent, is a grooved wave-line upon a strip or sheet of copper or other metal, as shown in Figs. 1, 4, 6, and 7, and for the reproduction of the recorded sounds it has the advantage over the ordinary records in tin-foil, wax, &c., that it is not sensibly attacked by the reproducing-stylus, and will stand an indefinite number of reproductions without the slightest variation in the accuracy and loudness of the reproduced sounds.

The copied record is fixed at both ends to the bars *c d*, as shown in Fig. 7, and is placed upon the elastic support f' upon the drum in the same manner as has been described with reference to the original record-strip, and as is illustrated in Figs. 1 and 4. Care must be taken that the two ends of the undulatory groove y meet exactly, as will be readily understood. This condition of the apparatus is shown in Fig. 1 with the engraven record upon the drum and the free end of the stylus entering the undulatory groove. If, now, the drum is rotated with uniform speed, the end of the stylus will be forced to follow the undulations of the groove y, and the diaphragm will be vibrated positively in both directions in strict accordance therewith, and will therefore reproduce the exact sounds which originally produced the record. This peculiarity of positive vibratory movement in both directions of the diaphragm is a feature which also distinguishes my method and my apparatus from others heretofore used.

In the phonograph and graphophone the end of the reproducing-stylus which bears upon the indented or engraved record has a vertical upward and downward movement. It is forced upwardly in a positive manner by riding over the elevated portion of the record, but its downward movement is effected solely by the elastic force of the diaphragm, which latter is always under tension. In my improved apparatus the stylus travels in a groove of even depth and is moved positively in both directions. It does not depend upon the elasticity of the diaphragm for its movement in one direction. This I consider to be an advantage, since by this method the whole movement of the diaphragm is positively controlled by the record, and is not affected or modified by the physical conditions of the diaphragm, which conditions necessarily vary from time to time and constitute some of the causes of imperfect reproduction of recorded sounds.

In practicing my method of recording and producing sounds I am not limited to the use of the identical apparatus herein shown and described. This apparatus may be varied indefinitely without seriously impairing its utility for the purposes in view. Thus it is not absolutely necessary that a diaphragm should be used for receiving the impact of sound-waves in recording and for remitting sounds in reproducing. Any sonorous body of whatever shape and material may be used in lieu of a diaphragm proper. The recording-surface need not be mounted upon a drum, but may be supported in any suitable manner upon a support of any description which is adapted to move the same under the stylus evenly and with approximately uniform speed. Nor do I confine myself to the use of lamp-black as a substratum for the phonautographic record, although I have found this substance to yield excellent results. Any other substance which adheres well to the support and may at the same time be removed from the same with a minimum force may be employed.

While I have found the process of photo-engraving to yield admirable copies of the phonautographic record, I do not mean to confine myself to this process to the exclusion of other processes for copying and multiplying the original record in solid resisting material; and it will be readily understood that the details of construction of my apparatus and the manipulations of the same may be greatly changed without departing from the fundamental idea of my invention.

I do not herein claim the apparatus shown and described, either generically or specifically, as a whole or in part, since the same forms the subject of another application for patent previously filed by me and of which this is a division.

What I do claim, and desire to secure by Letters Patent, is—

1. The method or process of recording and reproducing spoken words and other sounds, which consists in first drawing an undulatory line of even depth in a traveling layer of non-resisting material by and in accordance with sound-vibrations, then producing the record thus obtained in solid resisting material, and finally imparting vibrations to a sonorous body by and in accordance with the resisting record, substantially as described.

2. The method or process of reproducing sounds recorded phonautographically, which consists in copying the phonautographic record in solid resisting material, and then imparting vibrations to a sonorous body by and in accordance with the copy of the orignal record, substantially as described.

3. The method or process of reproducing sounds recorded phonautographically, which consists in copying the phonautographic record in solid resisting material by the process of photo engraving, and then imparting positive to-and-fro movements to a sonorous body by and in accordance with the copy of the original record, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EMILE BERLINER.

Witnesses:
JULIUS SOLGER,
JACOB G. COHEN.

(No Model.)

T. A. EDISON.

PROCESS OF MAKING PHONOGRAM BLANKS.

No. 382,417. Patented May 8, 1888.

Fig. 1.

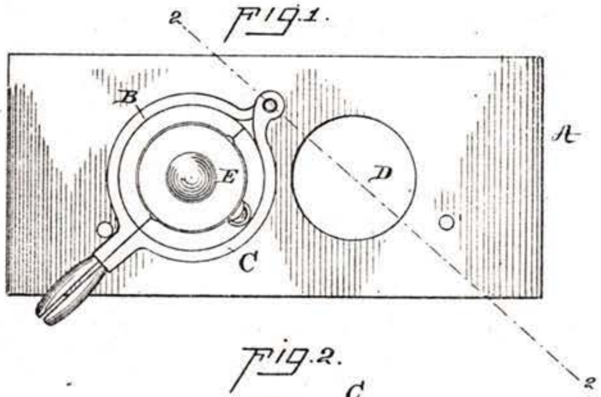


Fig. 2.

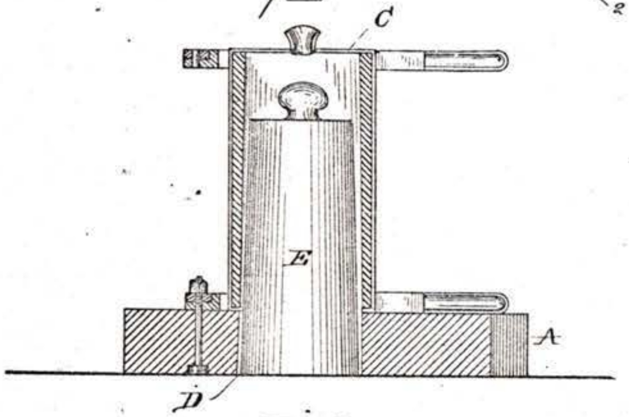
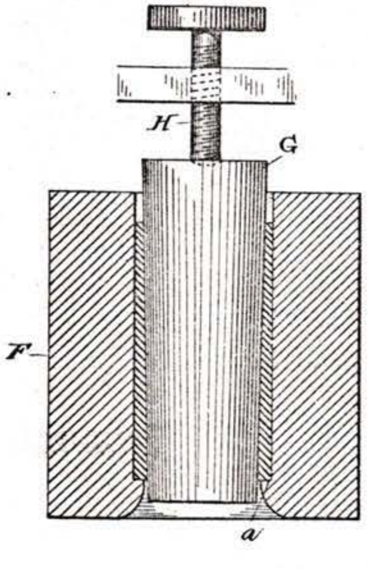


Fig. 3.



Witnesses.

E. C. Rowland.

William Pelzer

Inventor.

Thomas A. Edison

By his Attorneys Dyer & Seely.

THE NORRIS PETERS CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF MAKING PHONOGRAM-BLANKS

SPECIFICATION forming part of Letters Patent No. 382,417, dated May 8, 1888.

Application filed February 4, 1888. Serial No. 263,047. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes of Making Phonogram-Blanks, (Case No. 758,) of which the following is a specification.

The object I have in view is to produce a method or process of making wax phonogram-blanks which will result in a more accurate blank and one having a better surface for receiving the phonograph-record.

The blank which I prefer to use is a hollow tapering cylinder; but the process is applicable to blanks of other forms. It is hereinafter described as applied to the tapering cylindrical blanks.

I first mold the wax blank by pouring melted wax into a mold having the necessary shape for producing a hollow tapering cylinder. The molded cylinder is then pressed in a die of highly-polished metal, (preferably speculum metal,) and it is thereby given the exact shape and size desired, both externally and internally, and its surfaces are given a high polish, so that upon the removal of a blank from this die it will be ready for use without any cutting. The blank is removed from the mold and placed in the die while it is still partially plastic—say after its temperature has fallen to about 100° Fahrenheit.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of the mold. Fig. 2 is a cross-section of the mold on the line 2 2, when the mold is swung to the right; and Fig. 3 is a view, partially in section and partially in elevation, showing the pressing of the blank in the finishing-die.

The mold for molding the cylinder is shown, for convenience, as of the particular construction described in a prior application for patent, (Serial No. 260,923,) although it may be of any other suitable construction. It is composed of a base, A, upon which the mold is pivoted, such mold being composed of two parts, B C, adapted to be separated for opening the mold, and also adapted to be swung bodily upon the base, so as to bring the mold over the opening D in the base or over the solid portion of the base. E is the tapering core of the mold. The mold is swung to the left over the solid part of the base, and the core being placed in it and the mold closed, hot wax is poured into the mold, forming a cylinder around the core E. When the wax is partially cool, sufficiently so to retain its shape, the mold is swung to the right over the opening D and the core E is pushed down into the opening D, as shown in Fig. 2, thus permitting the wax to contract without breaking. After the cylindrical blank has cooled down to a temperature where it is still slightly plastic—say 100° Fahrenheit—it is removed from the mold and is placed in the die F. This die may be a divided die or one that is solid. It has a cylindrical opening with a shoulder, *a*, at its lower end. A tapering plunger, G, pressed forward by a screw, H, is forced into the bore of the phonogram-blank, pressing the blank against the walls of the surrounding die, and giving it the exact shape and size both externally and internally that it is desired the blank should have. The die and its plunger are made of highly-polished metal. Speculum metal is preferably used for this purpose. The plunger is then removed from the blank and the blank removed from the die, when it will be ready for use on a phonograph. The blank formed in this way is accurate in its size and has a highly-polished recording-surface, which improves the articulation of the phonograph, and also has its bore accurately tapered, so as to fit the cylindrical phonogram-carrier of the phonograph.

What I claim is—

1. The process of making wax phonogram-blanks, consisting in first molding the blank from melted wax and then pressing the blank in a polished die, substantially as set forth.

2. The process of making cylindrical wax phonogram-blanks, consisting in first molding the cylindrical blank from melted wax and then pressing the blank both externally and internally in a polished die, substantially as set forth.

This specification signed and witnessed this 30th day of January, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

METHOD OF MAKING PHONOGRAM BLANKS.

No. 400,649. Patented Apr. 2, 1889.

FIG. 1.

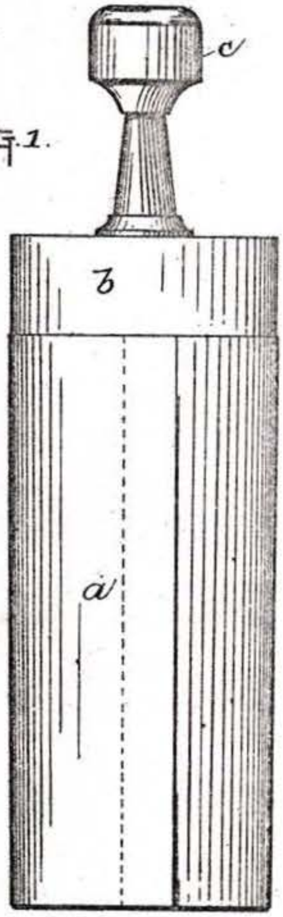


FIG. 2.

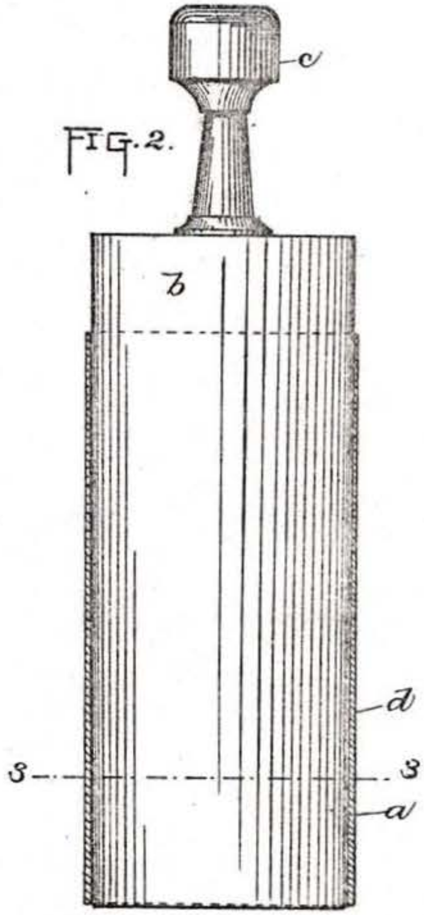
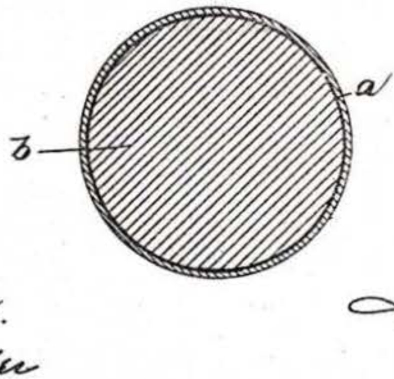


FIG. 3.



WITNESSES:

E. C. Rowland.

William Pelzer

INVENTOR

Thomas A. Edison

BY

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

METHOD OF MAKING PHONOGRAM-BLANKS.

SPECIFICATION forming part of Letters Patent No. 400,649, dated April 2, 1889.

Application filed October 11, 1888. Serial No. 287,843. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Methods of Making Phonogram-Blanks, (Case No. 807,) of which the following is a specification.

The object of my invention is to produce, in a simple and expeditious manner, cylindrical phonogram-blanks made of paper or other flexible material covered with a material which can be indented by the recording-point of the phonograph.

In carrying my invention into effect, I first take a sheet of paper or other flexible material of the proper size, and I wrap this upon a tapering core which is provided with a handle. I secure the paper together at its edges, and I then, holding the core by the handle, dip it into a bath of the material to be applied to it while such material is in a softened condition. This material is preferably a wax or a composition of waxes or a suitable metallic soap. After the paper is dipped and becomes coated to a sufficient thickness with the indenting material, it is placed in a lathe, and its surface is turned off into a true cylindrical form, it being at first in the tapering form of the dipping-core. The phonogram-blank being then removed from the core is ready for use.

My invention is illustrated in the accompanying drawings.

Figure 1 is an elevation of the paper wrapped on the dipping-core; Fig. 2, a section of the same after dipping and turning, the core being in elevation; and Fig. 3, a cross-section on the line 3 3 of Fig. 2.

The sheet of paper *a* is wrapped upon the tapering cylindrical core *b*, which has a handle, *c*, and its overlapping edges are gummed or otherwise secured together. The paper thus assumes a form like that of the core. The core is then held by the handle and the paper dipped into the material, as above described, and this material *d* adheres to the surface of the paper, whereby a hollow cylinder tapering both inside and outside is produced. This is then turned off in a lathe into the shape shown in Fig. 2—that is, so that it has a cylindrical outer surface and a tapering bore, whereby on being removed from the forming-core it can readily be placed upon the cylinder of the phonograph and recorded upon.

In placing the cylinder in the lathe, I prefer to leave it on the forming-core, this being provided with depressions at its ends (shown in dotted lines) for holding it in the lathe.

What I claim is—

The method of making a phonogram-blank, which consists in wrapping a sheet of flexible material upon a tapering cylindrical core, dipping the same into the sound-recording material, which is caused to adhere to its surface, and then turning off the surface of such material into a true cylindrical form, substantially as set forth.

This specification signed and witnessed this 29th day of September, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(Specimens.)

I. W. HEYSINGER.

PHONOGRAPH TABLET.

No. 460,338. Patented Sept. 29, 1891.

Fig. 1.

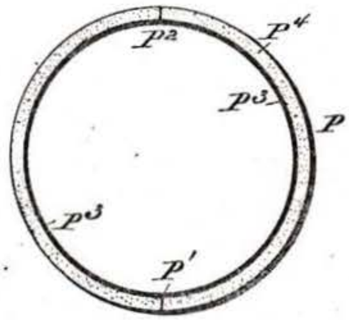

P2
P4
P3
P
P3
P'

Fig. 2.

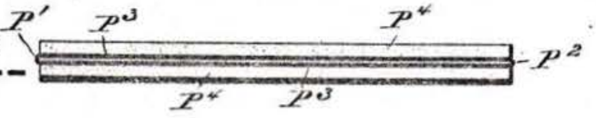
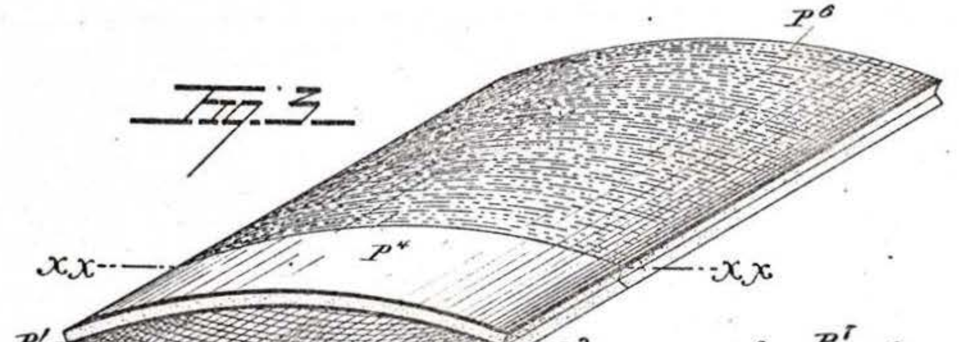

P'
P3
P4
P2
P4
P3

Fig. 3.


P6
x x
P4
x x
P'
P2
P3

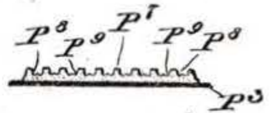
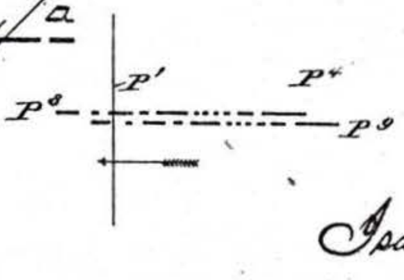

P8
P9
P7
P9
P8
P3

Fig. 4.

Fig. 4a



WITNESSES:

Jno. Nolan

Joshua Pusey.

INVENTOR

Isaac W. Heysinger.

UNITED STATES PATENT OFFICE.

ISAAC W. HEYSINGER, OF PHILADELPHIA, PENNSYLVANIA.

PHONOGRAPH-TABLET.

SPECIFICATION forming part of Letters Patent No. 460,338, dated September 29, 1891.

Original application filed February 7, 1888, Serial No. 263,282. Divided and this application filed April 17, 1888. Serial No. 270,897. (No model.)

To all whom it may concern:

Be it known that I, ISAAC W. HEYSINGER, of Philadelphia, in the county of Philadelphia, and State of Pennsylvania, have invented a certain new and useful Improvement in Sound Recording and Reproducing Tablets for Phonographs, of which the following is a full, clear, and exact description, reference being had to the drawings accompanying and forming part of this specification, in which—

Figure 1 is a view in cross-section of the collapsible tablet expanded into a cylinder, as when placed upon the cylinder of a phonograph for use. Fig. 2 is a like view of the same flattened down or collapsed for mailing purposes or permanent preservation. Fig. 3 is a perspective view of a like tablet collapsed, but not quite flattened, and having its surface partly written over in the phonograph, and also shows the transverse line upon which the surplus may be cut off for subsequent use and to lighten the tablet for mailing or other purposes. Fig. 4 is a sectional view taken upon one side of the tablet and in which the section is across the lines and grooves formed by the stylus of the phonograph, and Fig. 4^a a top view of the grooves P^8 and P^9.

The lettering in all the figures is uniform.

The subject-matter of my present application originally formed a part of my application for Letters Patent, Serial No. 263,282, filed February 7, 1888, and has been divided therefrom to include the tablet in a separate patent. The said original application comprised a working phonograph with which the tablets which form the subject-matter of this divisional application were adapted to be used, and reference is made to that application to show such manner of use, though the tablets herein shown, described, and claimed are adapted to be used with any suitable phonograph, and are not limited to the specific devices shown and described in said original application; and the said sound recording and reproducing tablets, surfaced as herein described and claimed, are not limited in my invention to the specific form shown, with reference to the machine described in my originally-filed application, but are applicable to machines using tablets of other form, and my tablets may be constructed in other shapes than those herein specifically shown without departing from the principles and scope of my invention.

My invention relates to the construction of a phonograph-tablet, or "phonogram," as it is sometimes called, upon which the stylus of a phonograph traces an indented, waved, or other inscribed record adapted to be subsequently reproduced in articulate speech by a reproducing-phonograph, in which I make my tablet in a cylindrical form having a flexible foundation of paper, cloth, or other suitable substance, upon which the plastic recording-surface is made by the application of a suitable composition, adherent thereto and having a surface adapted to be indented or inscribed by the stylus of a phonograph. Along the two opposite sides of this cylinder from end to end I cut through the composition down to the foundation, making a narrow slit along each side. When placed upon the cylinder of a phonograph for use, these slits are closed and the tablet forms a complete cylinder; but when removed from the machine the sides may be collapsed upon the foundation along the slitted lines, and the tablet becomes flat, having a double thickness and hinged joints at the sides and capable of being again erected into a cylinder at any time to be put into a similar machine for subsequent use to reproduce the sounds the record of which it may bear or to receive such record in case it has not been previously written upon. It is in its collapsed or flattened form very suitable for sending through the mails, and may be put, like a letter-sheet, into an ordinary envelope, and, if the surface be such as I prefer to use and which will be hereinafter described, it will bear any amount of hard usage without injury. These collapsed tablets also occupy very little space and may be tied up or packed in bundles, like postal-cards, for transportation, sale, use, or preservation after having received an inscribed record. I do not always make these tubular or cylindrical tablets with a single slit or cleft down each side; but more than two slits may be cut and more than two hinged joints may be used, if so desired. The plastic composition must of course be sufficiently flexible to permit the sides to be collapsed or flattened, or nearly flattened, though with an elastic surface of hard material the flattening may not be complete, but is made so by tying in bundles, inclosing in envelopes, or compression in other ways, after the cylinder has been collapsed. In certain cases these slits may not extend entirely down to the foundation, and in other cases they may extend partly through the foundation, while sometimes strips of flexible material may be glued or otherwise attached to the inside surfaces at the joints to form the hinges, or the whole tube may be made collapsible at any part. In manufacturing these tubular tablets I make them in long lengths and prefer to use a material woven or knitted into tubular form, which, stretched upon a flat former with parallel sides, or, preferably, upon a cylindrical mandrel, I paint or coat over with my plastic composition until a requisite thickness of surface has been secured, which may be about the one-twentieth of an inch, using the composition hot and in a fluid or semi-fluid state. When cooled and hardened, I run a graduated slitter down each side and cut through the composition to the desired depth. The long tube then removed from the mandrel, I cut it into suitable lengths for use, and, as shown in my former application of February 7, 1888, with the machine therein described and claimed, I prefer to cut these lengths longer than the cylinder of the machine, so that the tablet applied thereto may project from the free end of the cylinder thereof. When a portion has been inscribed by the stylus of the machine, the remainder may be clipped off with a pair of scissors, when flattened, and used again until the whole has been written over without waste.

My invention also relates to the composition of the plastic surface of a phonograph-tablet; and it consists in using a material or composition therefor which, when used in the machine for receiving a record, will be soft and plastic, but which said composition, after receiving the said record, is rendered hard and resistant, so that the record once made may be reproduced indefinitely under the stylus of a reproducing-phonograph without abrasion or injury to the record, and also that these tablets, bearing their records, may be piled up in bundles, sent through the mails, and subjected to rough usage without crushing down the record or impairing its use for reproducing the sounds of the same.

Referring to the drawings, in Figure 1 I have shown in transverse section a tubular foundation of flexible material P^3, formed from a woven tube or by pasting together the edges of a strip of paper, muslin, or like substance. A suitable paste or glue for this purpose is made of fish-glue, with boiling water, the joint treated with a solution of bichromate of potassa afterward, (which renders the glue insoluble,) and then washed, if desired. This joint is both flexible and insoluble. Upon the outer surface of this tubular and flexible foundation P^3 is applied the plastic composition P^4 to the requisite thickness, the outer surface being smooth and even. It may be made so in a lathe, if desired, before removal from the cylindrical mandrel upon which the tube P^3 is fitted; but for use in the machine which forms the subject of my application of February 7, 1888, no special accuracy of surface is required, as the plow-point therein described will cut to a definite distance from the foundation of the cylinder, irrespective of variation of the surface, and the record produced at the bottom of such grooves will be regular under the same circumstances.

The composition which I prefer to use and which forms a part of this invention is made by mixing gutta-percha with resin and melting the same together with or without the addition of other fusible or miscible substances to render the composition more or less soft and plastic when cold or when warmed for use in the machine. Gutta-percha and resin melted together in equal parts, the proportion varying with differences inherent in different samples, make a composition hard and elastic at ordinary temperatures, but soft, plastic, and inelastic at a temperature of from 110° to 140° Fahrenheit, and will answer the purpose very well. It becomes fluid at or below the boiling-point of water and can be readily applied with a brush or otherwise to the foundation P^3 repeatedly, if necessary, until a proper thickness is secured. This composition or a similar one so modified by like temperature I prefer to use, when I soften the plastic surface of my tablet by artificially-applied heat at the time the record is being made and allow the said surface to harden by exposure to the ordinary temperature of the atmosphere, the same being repeated as often as desired, as shown and described in my application of February 7, 1888; but I sometimes prefer to harden my composition by the action of chemicals applied to the surface thereof in solution or otherwise, and in such case I usually add more or less starch to the said composition when being prepared, and such composition is very readily rendered hard and elastic by a solution of chloride of zinc or other concentrated chlorides. Such methods of hardening substances are numerous and are well known for many purposes in the arts. I also sometimes use alcohol as a solvent instead of moist or dry heat, and in such case I increase the proportion of resin used with my gutta-percha or use a resin-soap, so that the solvent action of alcohol applied to the surface will render the same soft and plastic until the said alcohol evaporates, when the said surface will resume its normally hard and elastic condition. I also use other well-known mechanical equivalents besides the modifications enumerated above; but for cheapness, readiness of application, and convenience I prefer to use a normally hard and resistant surface, softened temporarily while being written upon by artificially-applied heat and subsequently restored to a hard and resistant condition by the coolness of the atmosphere at ordinary temperatures. This softening may be accomplished by placing the tablet for a few minutes in a pail of moderately-hot water and then applying the same to the machine to receive the record made by the stylus thereof. A tablet thus heated will remain soft if made of approximately equal parts of gutta-percha and resin with or without the addition of a few drops of glycerine or molasses for a period of from ten to twenty minutes; but I prefer to employ the heating device shown, described, and claimed in my application for Letters Patent hereinabove mentioned, as being more under control and capable of continuous use at any time. Such a surface, when thus written upon, may be subsequently used again, the former record having been expunged by passing a hot iron or the like over it and melting and smoothing down the same to form a new surface. Gutta-percha has a special value as an ingredient because, while most substances expand by heat and contract by cooling, the reverse is the case with gutta-percha, so that when this substance is used and the tubular tablet placed upon the cylinder of the phonograph and heated it not only becomes soft and plastic, but contracts upon the cylinder, so as to present a smooth, firm, and even surface for the stylus of the phonograph. The composition, thus applied to the foundation, as shown in the figures, and allowed to harden upon a mandrel, is divided longitudinally by the clefts or slits P' P^2, which, as shown, extend down to the foundation. These slits may be made in the composition P^4 when soft or after partially or wholly hardening. The hard elastic-surfaced cylinder cut into suitable lengths when removed from the mandrel or former presents a surface resistant against injury, which may be readily collapsed upon the hinges P' P^2, as shown in Figs. 2 and 3. As the cylinder or mandrel upon which the foundations are laid is the precise diameter of the cylinder of the phonograph, this tablet may be readily sprung open and slipped over the free end of the cylinder of the machine, when the clefts P' and P^2 will be closed and the surface of the tablets present a smooth outer side. If removed from the cylinder of the machine when warm, it will flatten down completely, as shown in Fig. 2; but if allowed to harden before removal it will only partially collapse, as shown in Fig. 3; but in either case it may be made flat or cylindrical at will, and may be put into an ordinary envelope for mailing, like a common letter, or may be bundled up with others and stored away without the necessity of any special precaution, the composition being unaffected by water or moisture, mold, time, or accidental knocks or blows.

As shown in Fig. 3, these tablets, when made longer than required, may be readily cut off upon the line *xx xx* and the surplus used again. This is easily done when the tablet is collapsed by a pair of scissors or other means.

In Fig. 4 are shown the grooves P^6, made by the stylus of the recording-phonograph, corresponding in the figure to those made by my special machine, as described in my other application aforesaid; but the grooves of the record may be of any form and made by any sort of recording-stylus, and the tubular collapsible tablet may be modified to conform to the special requirements in any case and used with phonographic recording and reproducing instruments of other form and construction than the machine specifically shown, described, and claimed in my other application—to wit, Serial No. 263,282, filed February 7, 1888—with which my tablet as shown in the figures is especially adapted for use.

In certain cases, with a very flexible surface, it may not be necessary to cut the slits P' P^2 to any considerable depth, and in some cases the tablet in tubular form may be made collapsible without the use of specially-inscribed clefts, the foundation being thinned at certain places, or otherwise; but I prefer the form shown and above described, as the record is not in anywise impaired by the collapsing of said tubular tablet when such slits are used, however frequently the same may be repeated.

In Fig. 4 the groove P^6 is divided at the bottom thereof into two slightly-separated parallel channels P^8 P^9, and, as shown and described in my application for Letters Patent for a phonograph aforesaid, each of these grooves at its bottom contains an indented line of sound-record produced by the diaphragm of a phonograph acting at the same time upon two parallel styluses, one slightly in rear of the other, and producing an identical record in the slightly-separated subgrooves P^8 and P^9, but one of said records slightly in rear of the other as the said tablet rotates in the machine. A small part of such duplicate record is seen in Fig. 4^a, in which P^8 is the same as P^9, but slightly in advance, as shown by the direction of the arrow, so that one record crosses the cleft P' at a time when the other record is upon the solid surface of P^4, and any inequality due to the cleft P' is compensated for by the parallel record, acting through a duplicate reproducing-stylus at the same time and upon the same diaphragm. This duplicate record I use with the phonograph as shown, described, and claimed in my other application aforesaid; but it is not strictly necessary, the slits P' and P^2, if properly made, making a very slight difference, and, if the surface P^4 is hardened scarcely any, the blunt reproducing-stylus crossing the closed slit very readily; but the duplicate records assist in compensating for irregularity of surface generally or for variation in the substance, as was fully explained in my former application, and they are of use for other reasons, as in case of defect of the recording or reproducing stylus of the machine or of the cylinder or working parts thereof. For use in ordinary phonographs they may be dispensed with, if desired.

In making my composition for the surface of my tablets other gums or resins may be used, and linseed-oil may be used as one of the ingredients, as well as caoutchouc, in lieu of gutta-percha, a large number of like equivalents being known for all such substances in the arts; and I do not specifically confine myself to the use of any single ingredient, except as enumerated in the specific claims of those which hereinafter follow.

Having now described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A phonograph-tablet for the record and reproduction of sounds, consisting of two or more flexible leaves hinged together at their sides and adapted to be expanded into a cylinder to be extended over the cylinder of a phonographic machine, said leaves having surfaces adapted to receive the indentations or other record of sound produced by said phonograph, the said tablet adapted to be subsequently flattened upon said hinged sides when removed from said phonograph and subsequently expanded for use upon the cylinder of a sound-reproducing phonograph, substantially as and for the purposes described.

2. As an article of manufacture, a phonograph sound recording and reproducing tablet, consisting of a flexible foundation of paper, fabric, or the like formed into a tube, and a surface of plastic substance attached thereto, said surface adapted to receive and retain the sound-produced record of a phonograph, the said tubular tablet flexible and its sides adapted to be flattened together or collapsed for mailing or other purposes without destruction of said record, substantially as herein set forth.

3. As an article of manufacture, a laterally-collapsible tubular phonograph-tablet adapted to receive a phonographic record when expanded, to be subsequently collapsed and afterward again expanded for use in a reproducing-phonograph, substantially as described.

4. In a phonograph-tablet, the combination of the flexible tubular foundation P^3, the plastic recording-surface P^4, and the longitudinal clefts P' P^2, extended through said surface P^4 down to said flexible foundation P^3, substantially as and for the purposes herein shown and described.

5. The laterally-flexible collapsible tubular phonograph-tablet having the surface thereof longitudinally divided into two or more segments and provided with flexible hinged joints at the sides of said segments, substantially as described.

6. In a recording and reproducing tablet, a flexible foundation and a plastic surface formed into a tubular case, said surface having clefts extended along the sides of said tube through said plastic surface, said surface adapted to have a continuous record in said plastic material extending in parallel lines around said tube and crossing the clefts thereof, said tube adapted to be collapsed or flattened, and when again expanded, as around the reproducing-cylinder of a phonograph, having said lines of record on adjacent sides of said clefts match with each other as originally produced and produce a continuous record therefrom, substantially as described.

7. The tubular phonograph-tablet having a flexible foundation and a plastic surface, the same adapted to be collapsed or flattened for mailing or other purposes, said tubular tablet made longer than the cylinder of the machine upon which it is to be used, the surplus length adapted to be cut off with a pair of scissors or the like when the same is flattened, both sides cut simultaneously, if desired, said surplus serving for subsequent use as a separate tablet till all is used, substantially as and for the purposes described.

8. A tubular collapsible tablet for phonographs, having a flexible foundation of fabric or the like and a normally hard and resistant surface of considerable thickness, said surface adapted to be softened and made plastic by heat or otherwise for use in said recording-phonograph and subsequently hardened, substantially as described.

9. A collapsible tubular phonograph-tablet adapted to be flattened for preservation in bundles for mailing or other purposes and having a surface of considerable thickness composed of a substance adapted to be made plastic for use with a recording-phonograph and to be subsequently hardened and made resistant, substantially as described.

10. A phonograph-tablet consisting of two flat yielding surfaces, the edges thereof united by flexible hinges and the whole adapted to be expanded to form a cylindrical tablet extending over the cylinder of a phonograph for use therewith, said surfaces having a composition applied thereto to receive and reproduce the record of said phonograph, and said composition acted upon by the stylus of a recording-phonograph in a soft and plastic state and subsequently hardened for use under the stylus of a reproducing-phonograph, substantially as described.

11. In combination with the resistant and elastic surface P^4, adapted to be softened by heat and subsequently hardened, the flexible tubular foundation P^3, attached to and supporting said surface, and the longitudinal clefts P' P^2, extended through said surface down to said foundation, the whole adapted to be flattened when not in use and to be expanded to form an open tube or cylinder to closely fit over the cylinder of a phonograph and to be softened to present a plastic surface for receiving the record from the stylus of said phonograph, said surface subsequently made hard and resistant for the retention or

reproduction of said record, substantially as described.

12. In a phonograph recording and reproducing tablet, the surface composed of a body of gutta-percha with or without the admixture of modifying substances, said surface adapted to be softened by artificial heat for receiving the phonographic record and subsequently made hard and elastic by the ordinary atmospheric temperature, substantially as and for the purposes described.

13. A phonograph-tablet composed of gutta-percha and resin applied in a heated and fluid or semi-fluid state to a flexible foundation and forming a body thereupon, said body and said foundation composing a recording and reproducing tablet for phonographic purposes, substantially as described.

14. A phonograph-tablet composed partially of gutta-percha, adapted to be softened by heat and hardened by cold or chemicals for preservation subsequently to receiving the phonographic record, substantially as described.

15. A recording and reproducing tablet for phonographic purposes, consisting of a surface composed of substances adapted to be made more or less plastic by temperature or the application of chemicals and made hard and resistant subsequently to receiving the record of said phonograph by other temperature or chemicals, the whole constructed to be used for receiving the record in a soft and plastic condition and to be used for reproducing the said record in a hard and resistant condition, the said surface supported by a laterally flexible and collapsible foundation adapted to be flattened or folded together, substantially as described.

16. As an article of manufacture, a collapsible flexible tubular phonograph-tablet having a surface of considerable thickness to receive and retain the record made by the stylus of a phonograph or the like, said surface composed of a material softened by a moderate heat artificially applied thereto and subsequently hardened by the cooling effect of an ordinary atmospheric temperature, said tubular tablet adapted to be expanded for use upon the cylinder of a phonograph and at other times preserved in a collapsed or flattened state, substantially as described.

ISAAC W. HEYSINGER.

Witnesses:
J. L. HEYSINGER,
M. B. FENNINGER.

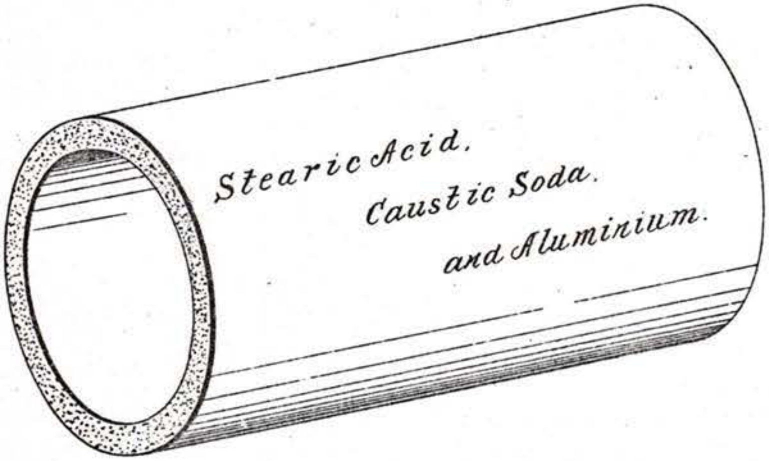
No. 606,725. Patented July 5, 1898.

T. H. MACDONALD.

MANUFACTURE OF GRAPHOPHONE TABLETS.

(Application filed Nov. 27, 1896.)

(No Model.)


Stearic Acid,
Caustic Soda.
and Aluminium.

Witnesses.
W. R. Edelen.
[illegible] Lewis.

Inventor.
Thomas H. Macdonald
by Philipp Mauro.
his attorneys.

UNITED STATES PATENT OFFICE.

THOMAS H. MACDONALD, OF BRIDGEPORT, CONNECTICUT, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF WASHINGTON, DISTRICT OF COLUMBIA.

MANUFACTURE OF GRAPHOPHONE-TABLETS.

SPECIFICATION forming part of Letters Patent No. 606,725, dated July 5, 1898.

Application filed November 27, 1896. Serial No. 613,615. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS H. MACDONALD, of Bridgeport, Connecticut, have invented new and useful Improvements in the Manufacture of Graphophone-Tablets, which improvements are fully set forth in the following specification.

This invention relates to the manufacture of tablets or blanks adapted to receive engraved records of sounds, and more particularly to the composition of matter of which the tablet is composed.

The recording material in order to answer well the requirements of the engraving method of recording sounds should be perfectly amorphous, slightly cohesive, and capable of being removed cleanly and smoothly in chips or shavings under the action of the recording-stylus when actuated by the feeble force of sound-waves. The material, moreover, should be sufficiently hard to withstand ordinary handling, to retain perfectly its form, and to resist the effect of ordinary changes of temperature. It should also be a stable compound or material in order that records made in it may be preserved for indefinite lengths of time.

As pointed out in Letters Patent No. 341,214, granted May 4, 1886, to C. A. Bell and S. Tainter, the properties above indicated reside in a greater or less degree in wax and wax-like substances—such as beeswax, paraffin, stearin, &c.—though by special preparation of these and similar substances their fitness for the purpose in view has been increased.

It has been heretofore proposed to use as a sound-recording material an insoluble soap made by saponification of any fatty acid by means of an earthy alkali, such as lime. It has also been proposed to employ a metal, such as lead, combined with stearic or oleic acid, and particularly a mixture of oleate and stearate of lead; but tablets made of insoluble lime-soap or of stearates or oleates of lead have never yielded commercially-successful results. Several practical difficulties have been encountered in endeavoring to make tablets composed wholly or in part of soap. The chief difficulty has been that the surfaces of such tablets become coated after a greater or less length of time with a bluish film having the appearance of mold and which has been termed "efflorescence." This is due to the presence in the material of hygroscopic compounds, which on being attacked by moisture work out to and spread upon the surface of the tablet.

I have found that lead in any form, as well as most of the salts of other metals which might be otherwise suitable for the purpose in view, give rise to hygroscopic compounds. This is particularly true of stearates and acetates of lead. Another difficulty that arises is the formation of crystalline or crystallizable compounds in the operation of making soap. The object of introducing a metal (or metallic salt) is to prevent all tendency to crystallization, it being of the first importance to secure a composition which shall be and under all conditions remain perfectly amorphous and presenting equal resistance to cutting in every direction. All ordinary commercial soaps have this tendency to crystallization in some degree, it not being possible to introduce sufficient sodium or soda salt to prevent all crystallization.

The accompanying drawing illustrates a common form of tablet for use in receiving engraved records of sounds.

In carrying out my invention, whereby all the conditions herein pointed out as essential are secured, I take stearic acid as nearly pure as can be obtained and convert it into soda soap in the manner hereinafter explained. The composition, however, differs from ordinary soap in that it contains no oleates, I having found that the presence of even a small quantity of oleate or oleic acid is detrimental. It is also important that the tallow or other source from which the stearic acid is obtained be completely deglycerinized. Except under these conditions the result will be unsatisfactory.

In converting the stearic acid into soap I produce only a partial saponification—that is to say, instead of using the chemical equivalent in caustic alkali of the fat acid I use about forty per cent. of that quantity of alkali—

thus producing what may be called a soap of about two-fifths saponification. This is the proportion which gives the best results, but is of course variable within limits. The controlling consideration is that the greater the quantity of alkali the higher will be the melting-point of the resulting soap, and a complete saponification will produce a soap which requires to melt at a temperature which will char it. As the material is to be molded into cylindrical or other forms, it must be capable of melting at a moderate temperature, say between 250° and 330° Fahrenheit. On the other hand, if the saponification be not carried far enough the material will be too soft and will run at a lower temperature than is desired. In this soap I have incorporated aluminium, which I have found to be the metal best suited in all respects for the purpose. This may be used in the form of aluminic hydrate or in the metallic state, powdered, or in small ingots. The method of introducing the metal is, moreover, important, owing to the tendency of sodium and aluminium when combined to form crystallizable compounds. Preferably the metal is first added to the soda-lye, forming with a portion thereof aluminate of soda, (sodium-ortho-aluminate,) which readily unites with the stearic acid subsequently added. The quantity of aluminium employed is relatively very small.

In order that the invention may be fully understood, I will give two formulas which have yielded the best results obtained.

Formula A: Stearic acid, free from oleic acid and glycerin, four hundred and eight pounds; aluminic hydrate, seven pounds; caustic-soda lye, eighty-five pounds. To this is added, for the purpose of "tempering," paraffin, ozokerite, or similar material, seventy-two pounds. The caustic soda is incorporated in water until a lye of 37.5° Baumé is obtained, and this is heated to its boiling-point, about 242° Fahrenheit. The aluminic hydrate is added and is quickly taken up by the lye. The stearic acid is melted and raised to about the same temperature and the compound of lye and aluminium added slowly thereto. It will unite readily therewith. It is preferred to employ about the temperature indicated, as thereby the formation of the composition proceeds gradually and without violent ebullition. The temperature may subsequently be raised to about 300° Fahrenheit and continued at that heat until the water is all expelled. The composition is now completed except for the addition of a material such as paraffin, ozokerite, or ceresin to bring it to the desired degree of hardness.

Formula B: Stearic acid, three hundred pounds; powdered aluminium, 1.5 pounds; caustic-soda lye, 37.5° Baumé, nine pounds; sal-soda dissolved in twelve gallons of water, sixty pounds; ceresin, sixty pounds. The sal-soda lye and caustic-soda lye may be united before the aluminium is added, or the latter may be added to the caustic soda and the two liquids then united. Instead of powdered aluminium I may use ordinary ingot-aluminium with results nearly if not equally as good. After the material is molded to the desired form it should be quickly cooled to ordinary temperatures.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The process of making a sound-recording material, by dissolving aluminium in soda-lye, and adding the solution to stearic acid, substantially as described.

2. The process of making a sound-recording material by melting stearic acid, free from glycerin and oleates, adding thereto soda-lye and aluminium, and heating the mass, substantially as described.

3. In the process of making a sound-recording material, the improvement consisting in adding to stearic acid soda-lye with which a metal such as aluminium has been united in such quantity as to produce partial saponification, and heating the mixture, substantially as described.

4. The process of making a sound-recording material by treating stearic acid with soda-lye in quantity sufficient to produce about a forty-per-cent. saponification, the lye containing a metal and heating the mixture, substantially as described.

5. The process of making a sound-recording material by forming a soda-lye, heating to about its boiling-point, adding a small quantity of aluminium thereto, heating pure stearic acid to about the same temperature, adding the compound of lye and aluminium and continuing the heating until the moisture is expelled, substantially as described.

6. The process of making a graphophone-tablet by forming a soda-lye, heating to about its boiling-point, adding a small quantity of aluminium thereto, heating pure stearic acid to about the same temperature, adding the compound, continuing the heating until the moisture is expelled, molding into the desired shape and then quickly cooling, substantially as described.

7. The process of making a sound-recording material, by partial saponification of stearic acid with soda-lye having aluminium united therewith, substantially as described.

8. The process of making a sound-recording material, by adding aluminic hydrate to caustic-soda lye, adding the compound to melted stearic acid, and heating the mixture, substantially as described.

9. The process of making a sound-recording material, by adding aluminium to soda-lye, adding the same to stearic acid, heating the mixture, and adding a softening material such as paraffin, substantially as described.

10. A composition of matter for a sound-recording tablet formed of pure stearic acid (free from oleic acid and glycerin) partly

saponified by caustic soda, and having aluminium incorporated therein, substantially as described.

11. The process of making a sound-recording material by adding aluminate of soda to stearic acid and heating the mixture, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

THOMAS H. MACDONALD.

Witnesses:
S. T. CAMERON,
REEVE LEWIS.

No. 670,442. Patented Mar. 26, 1901.

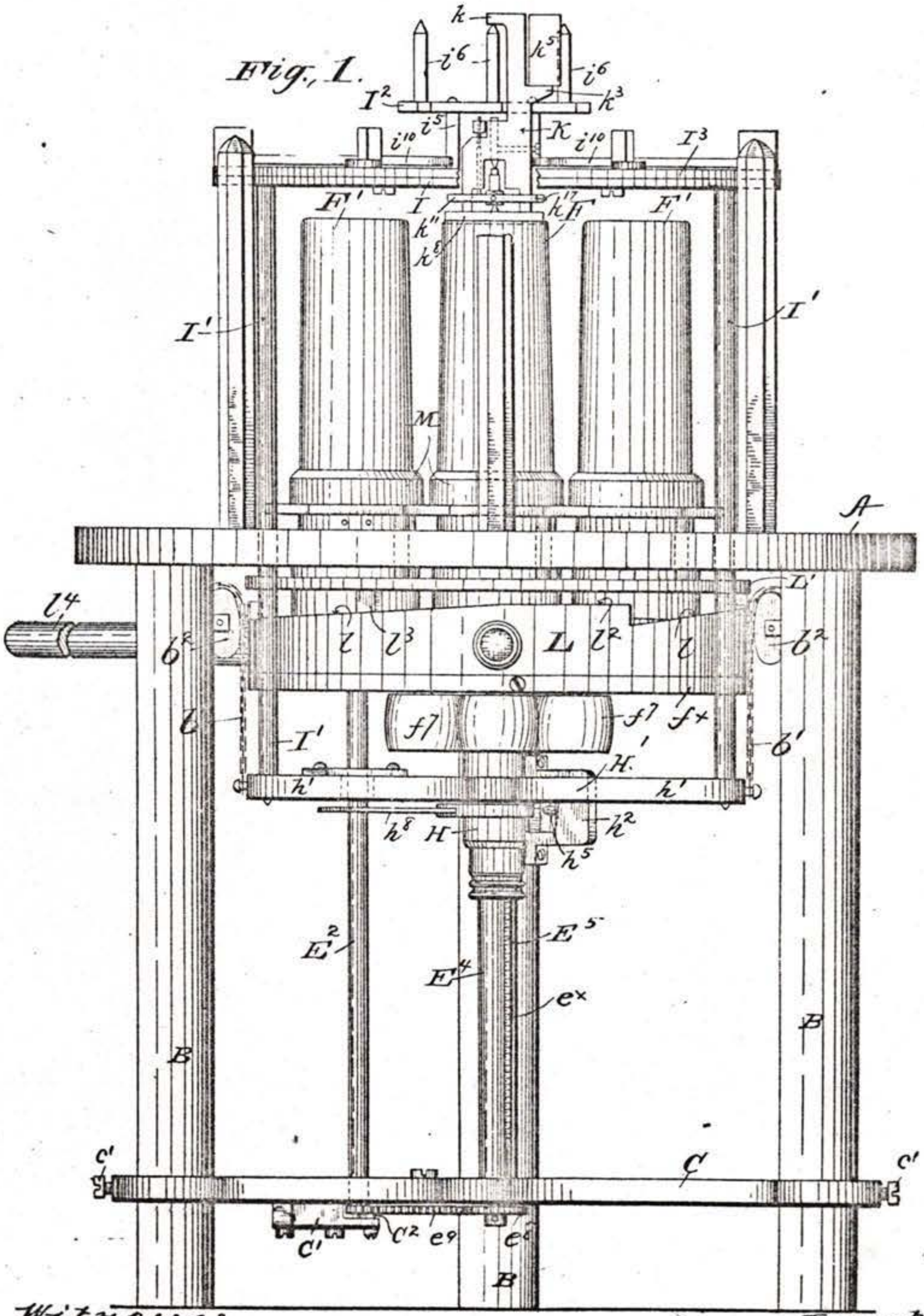
C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 1.

Fig. 1.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h5
E2
E5
E4
ex
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c'
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c'
C'
C2
e9
e6
B

Witnesses.
W. R. Edelen.
S. T. Cameron

Inventor
Charles S. Tainter
by Pollok & Mauro
his attorneys

No. 670,442. Patented Mar. 26, 1901.

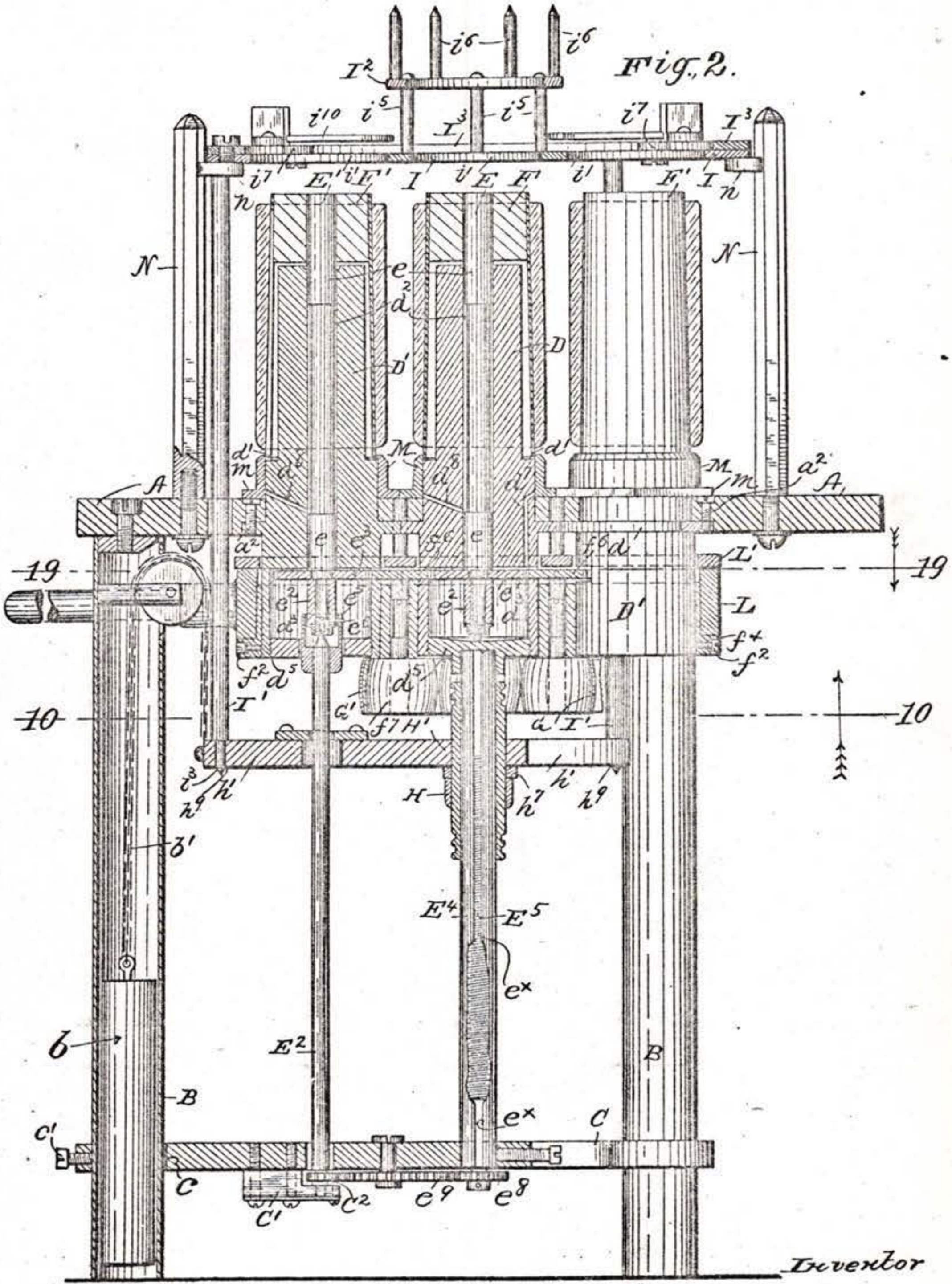
C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 2.

Fig. 2.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C
C'
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C'
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e^9
e^8

Witnesses
W. R. Edelen,
J. T. Cameron

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Charles S. Tainter
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his attorneys

No. 670,442. **Patented Mar. 26, 1901.**

C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) **11 Sheets—Sheet 3.**

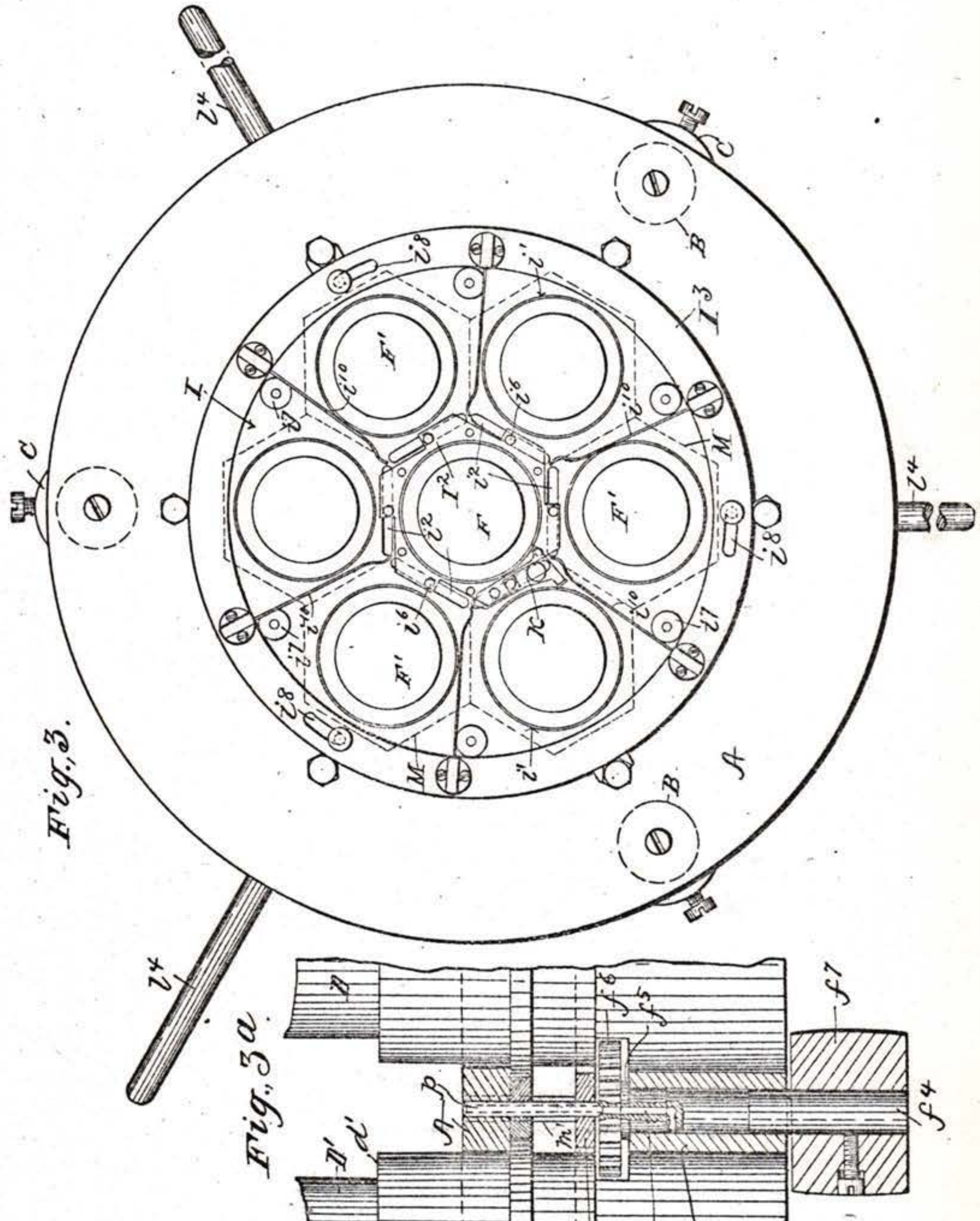

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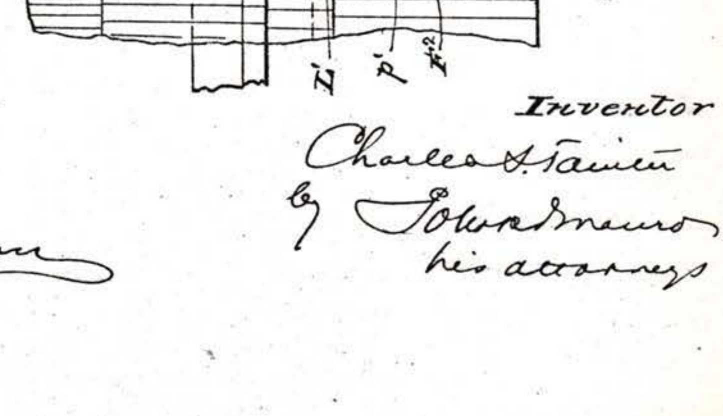
Fig. 3.



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f7
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A
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f4
D'
d'
L'
p'
F2

Fig. 3a

Witnesses
W. R. Edelen.
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No. 670,442. Patented Mar. 26, 1901.

C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 4.

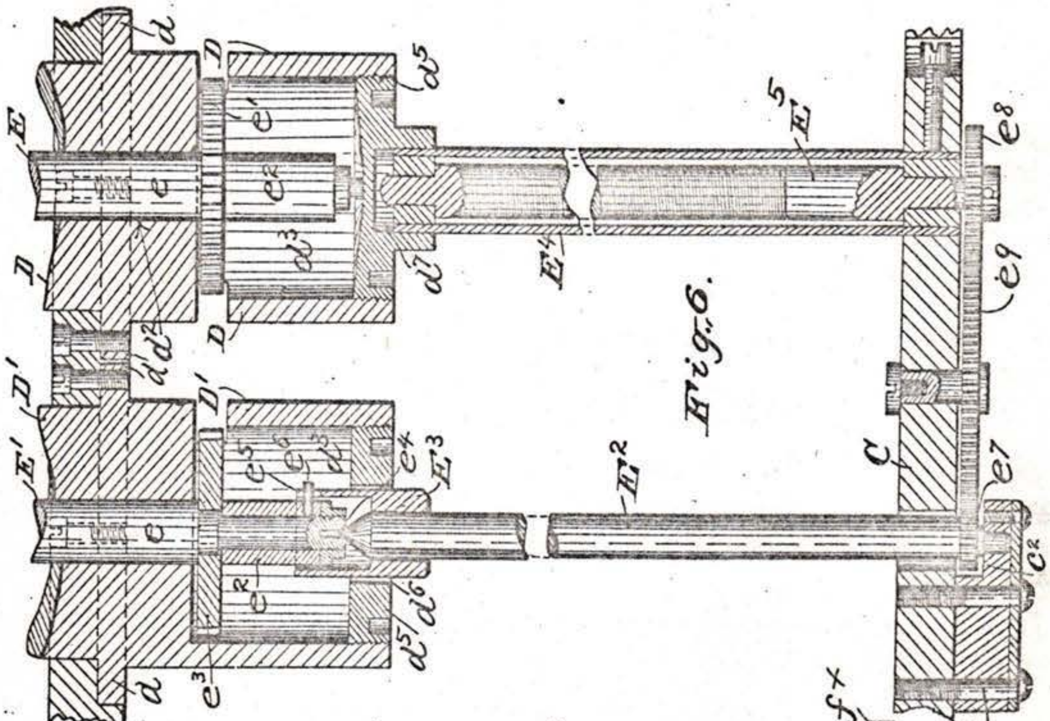
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Fig. 6.

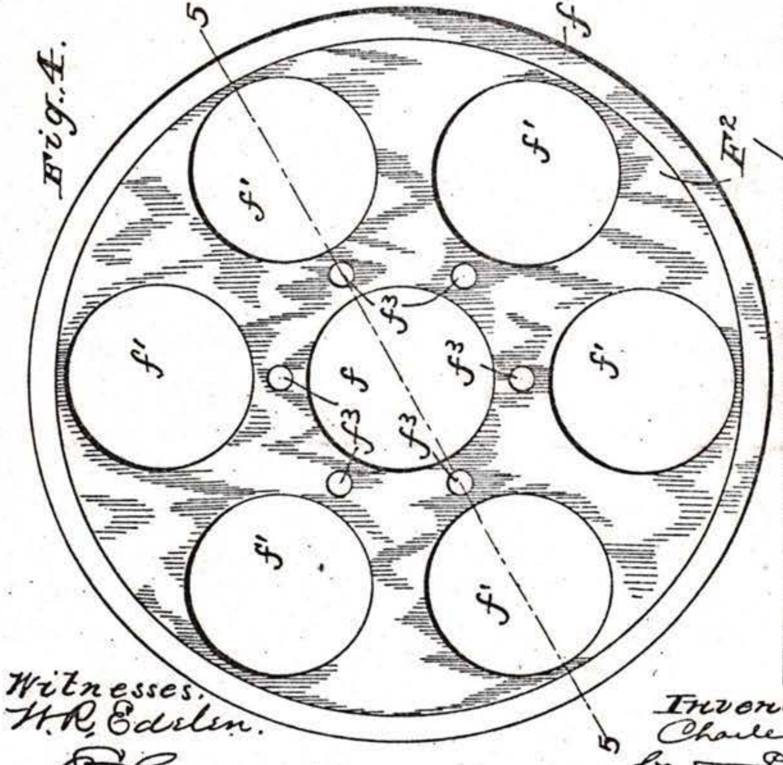
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Fig. 4.

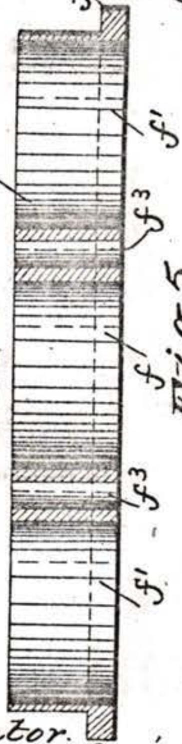

Fig. 5.

Witnesses:
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J. Cameron

Inventor.
Charles S. Tainter
by Pollok & Mauro
his attorneys

No. 670,442. Patented Mar. 26, 1901.

C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 10, 1898.)

(No Model.) 11 Sheets—Sheet 5.

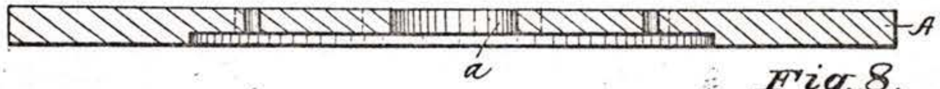

Fig. 8.

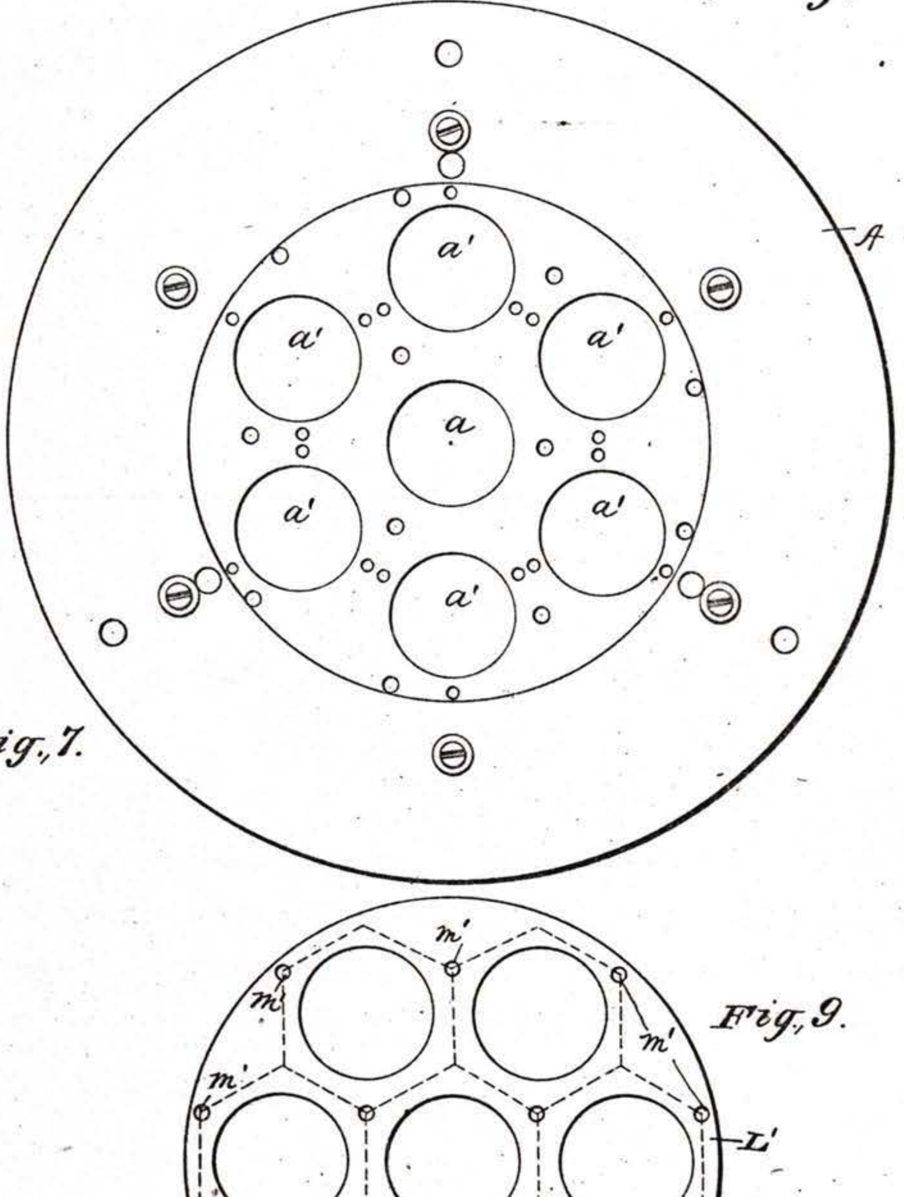

Fig. 7.

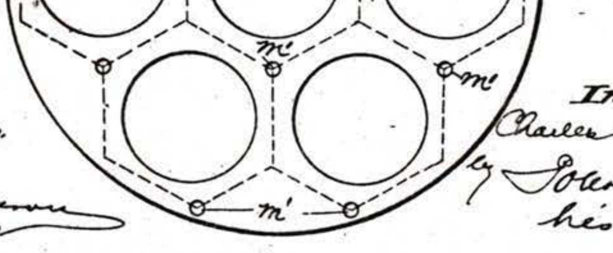

Fig. 9.

Witnesses
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J. T. Cameron

Inventor.
Charles S. Tainter
by Pollok & Mauro
his attorneys

No. 670,442. Patented Mar. 26, 1901.

C. S. TAINTER.

GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 6.

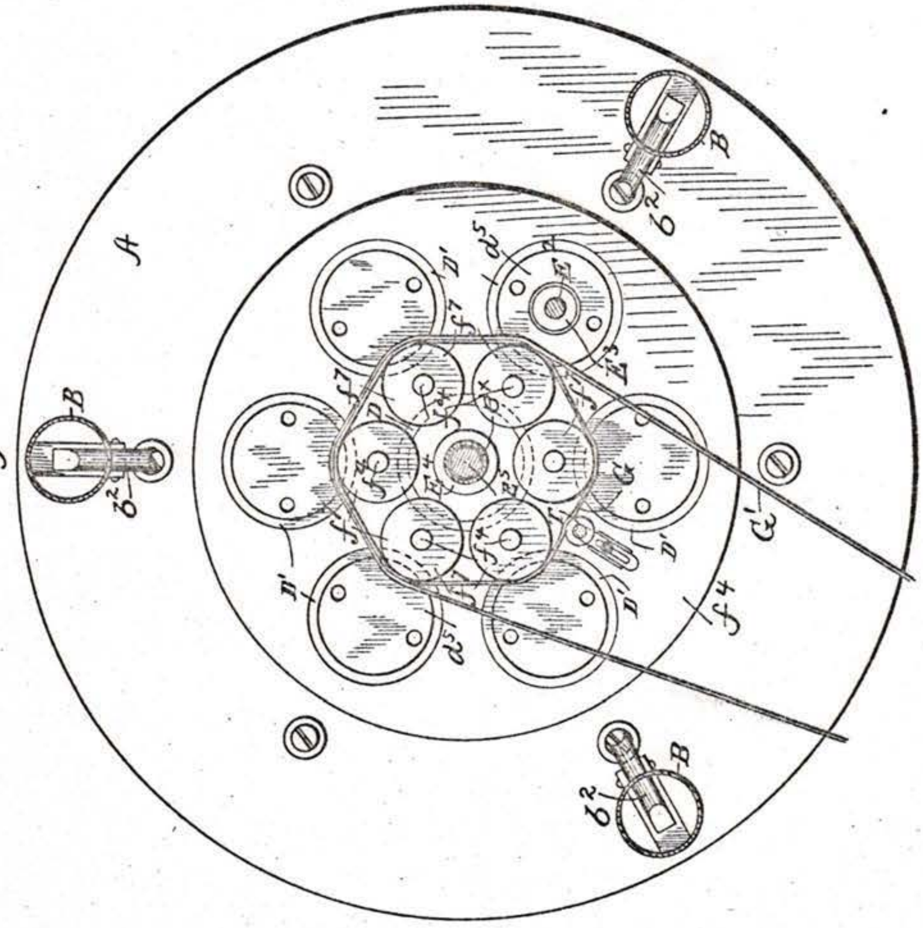
A
B
b^2
B
b^2
B
b^2
D'
d^5
E
E^3
f^7
D
f^4
d^x
C
C'
f^4
F'
d^5
D'

Fig. 10.

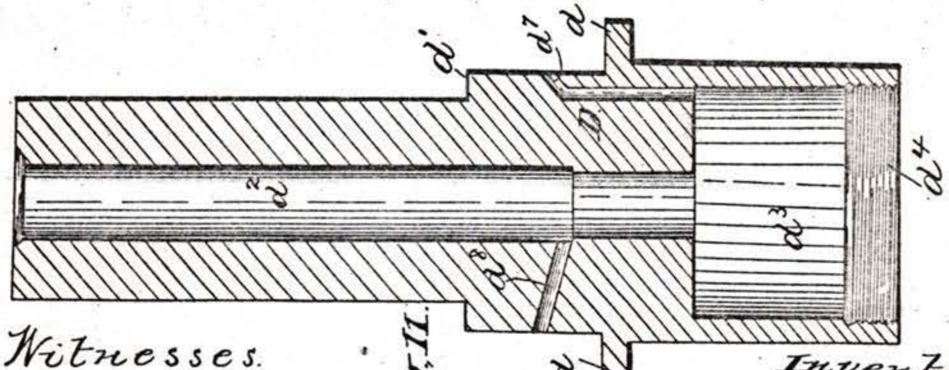
d'
d^7
d
D
d^4
d^2
d^3
d^8
d

Fig. 11.

Witnesses.
H. R. Edelen.
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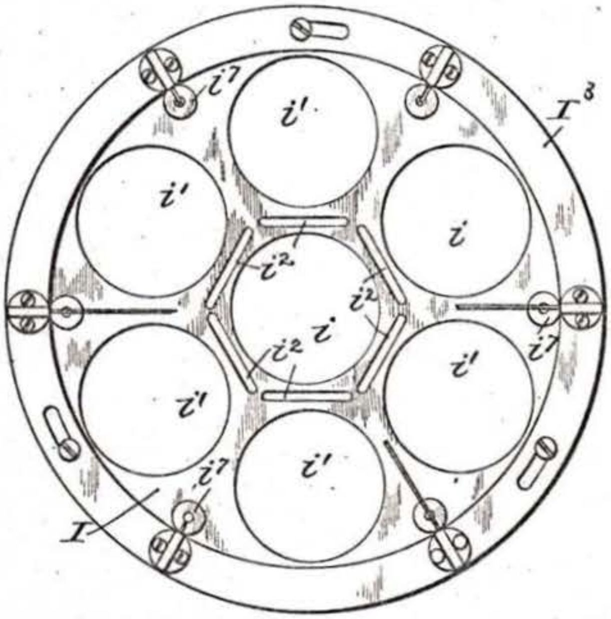
(Application filed Aug. 16, 1898.)

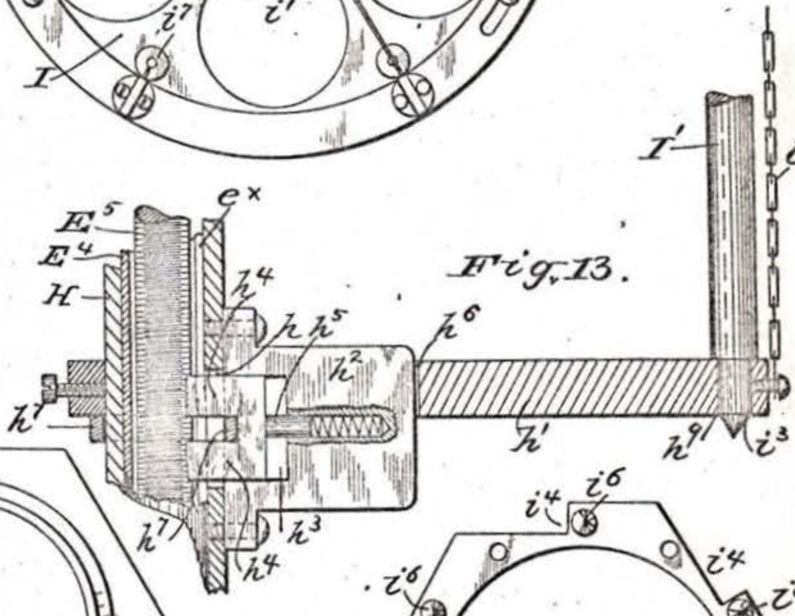
(No Model.) 11 Sheets—Sheet 7.

Fig. 12.



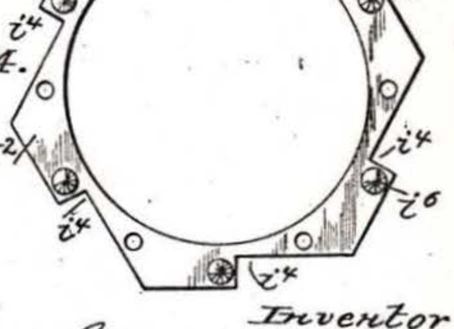
i7
i'
I3
i'
i
i2
i2
i
i2
i'
i7
i'
i'
i7
I

Fig. 13.



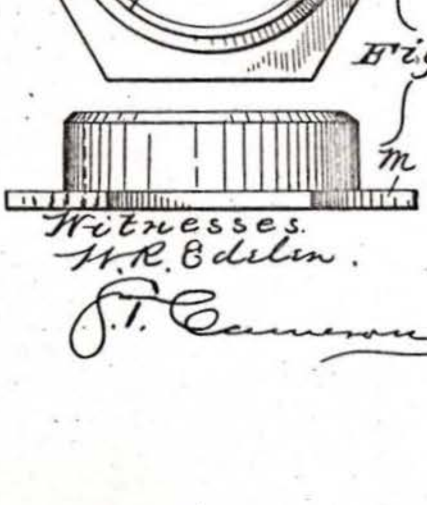
E5
E4
H
ex
h4
h
h5
h6
h2
I'
b'
h'
h'
h9
i3
h7
h3
h4

Fig. 14.



i4
i6
i4
i6
i6
i4
I2
i4
i6
i4
i4

Fig. 15.



Witnesses.
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(No Model.) 11 Sheets—Sheet 8.

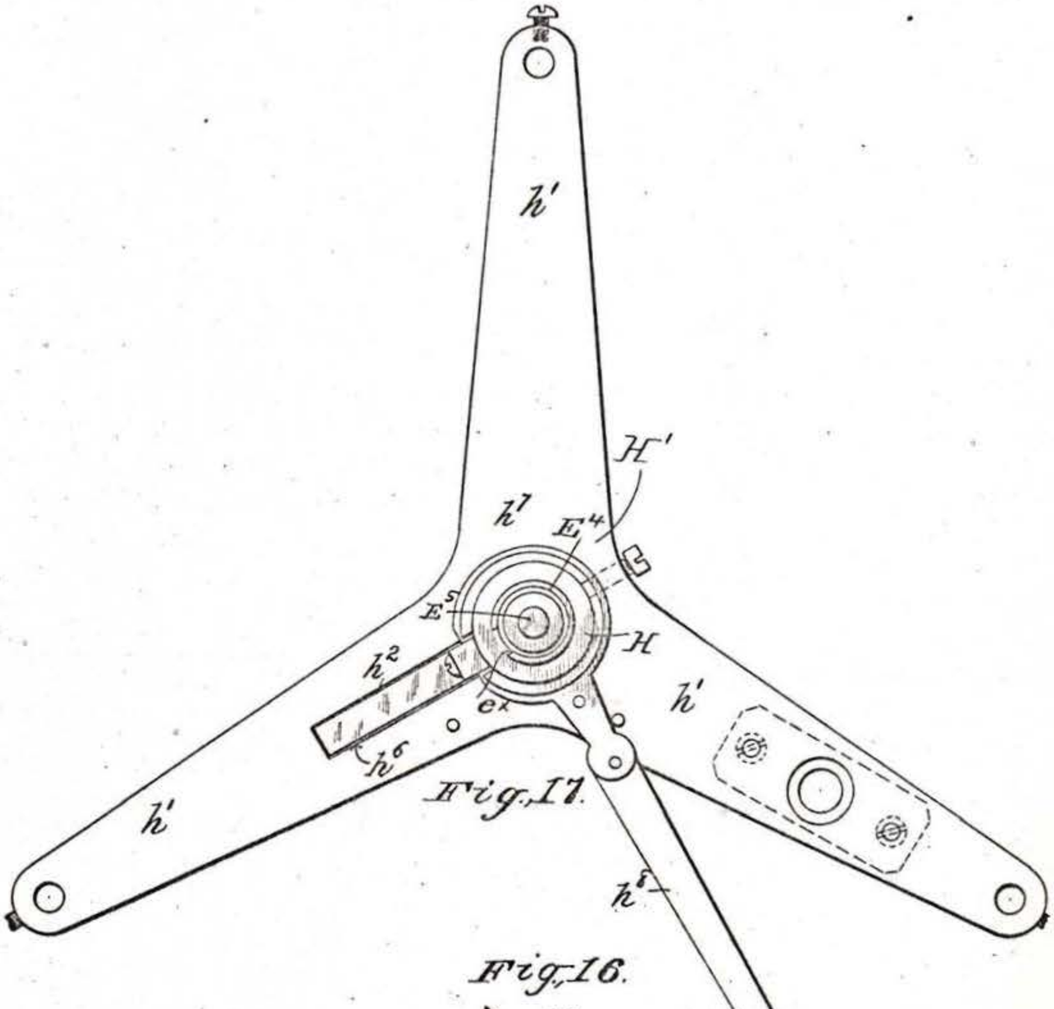
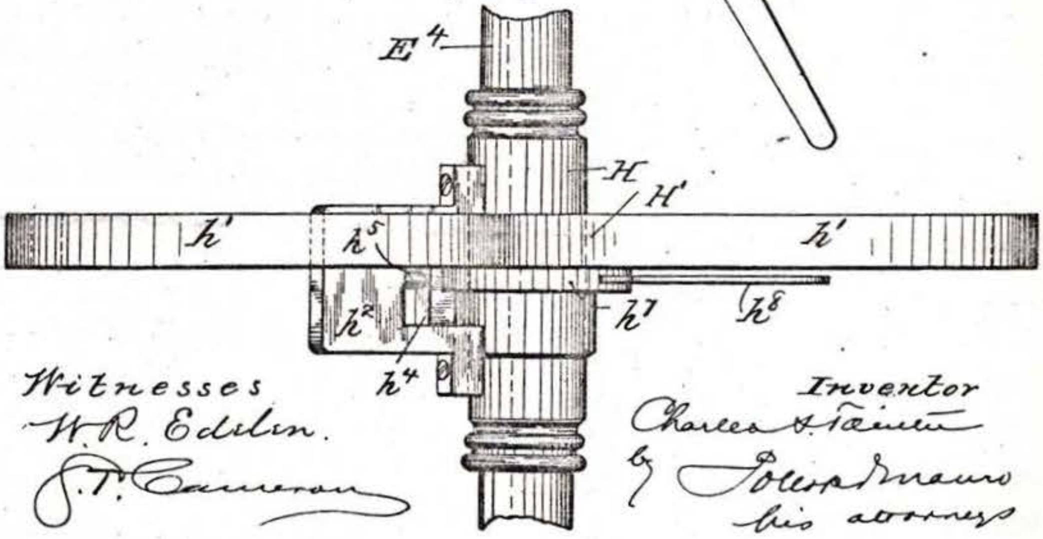

h'
H'
h7
E4
E5
H
h2
e2
h'
h6
h'
h8

Fig. 17.

Fig. 16.


E4
H
H'
h'
h5
h'
h2
h7
h8
h4

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GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 9.

Fig. 18.

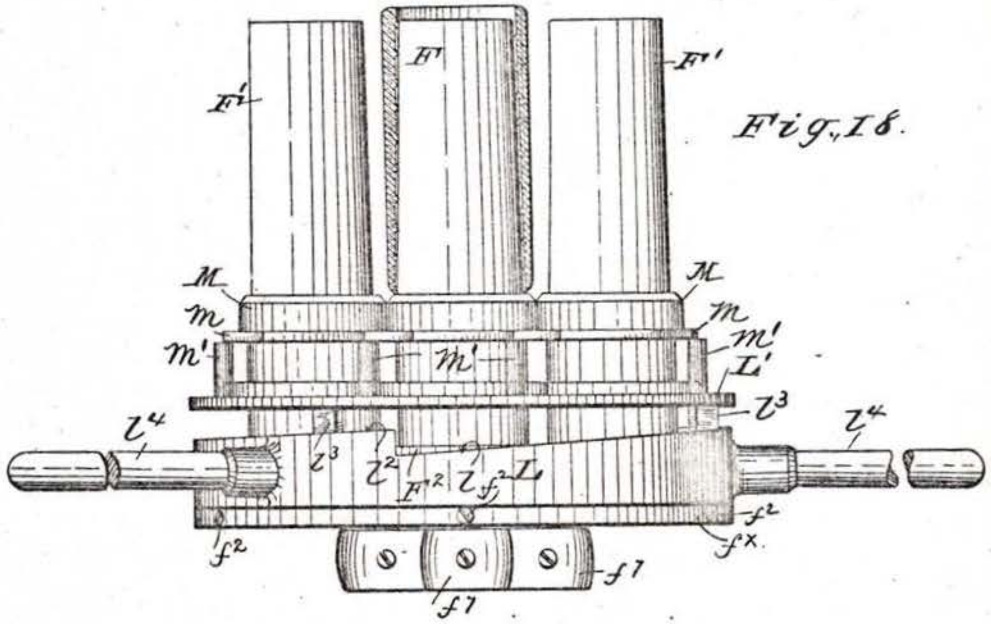
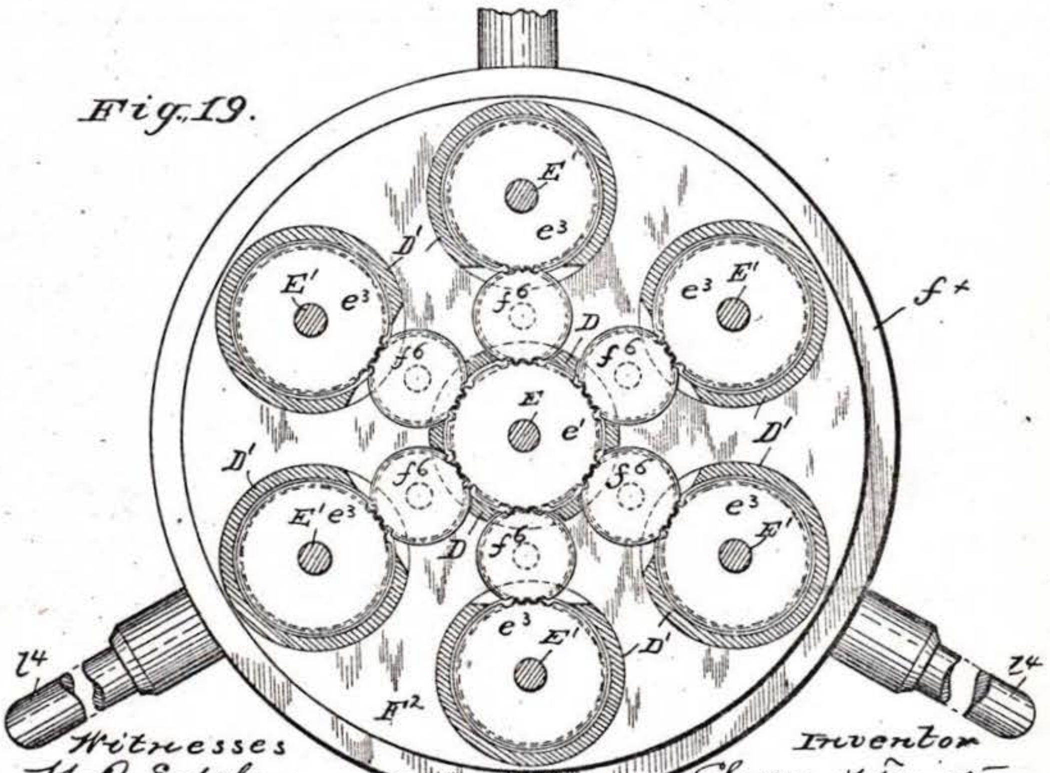

F'
F'
F'
M
M
m
m
m'
m'
m'
L'
l3
l4
l4
l3
l2
F2
l
f2
L
f2
fx
f2
f7
f7

Fig. 19.


E'
e3
D'
E'
e3
f6
D
f6
E'
e3
fx
f6
E
e'
D'
D'
f6
E'
e3
f6
e3
E'
D
f6
e3
E'
D'
F2
l4
l4

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GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

(No Model.) 11 Sheets—Sheet 10.

Fig. 20.

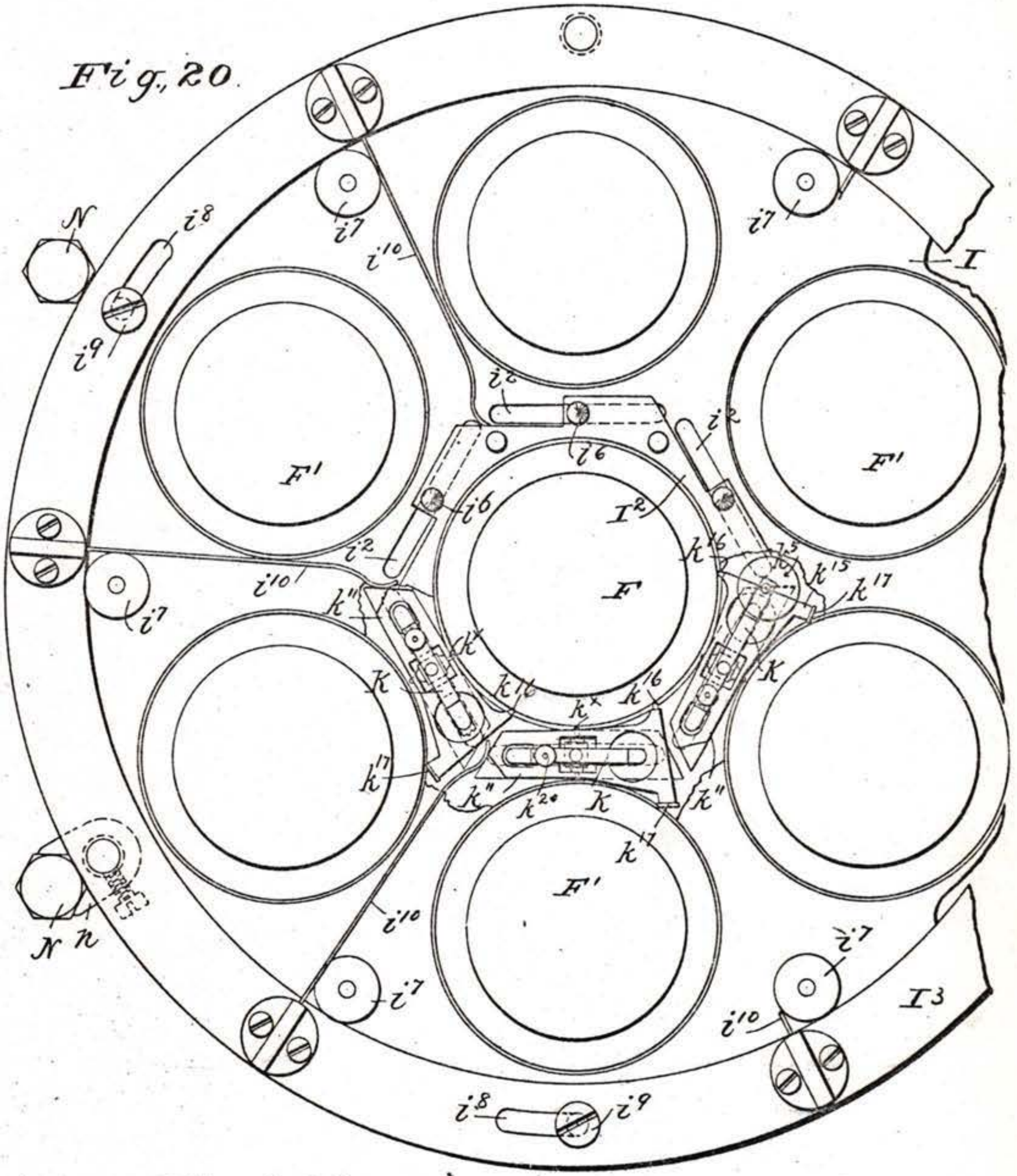
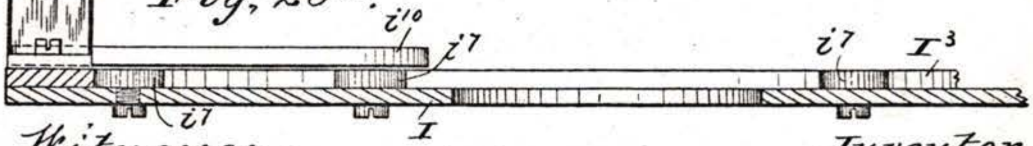

N
i8
i9
i7
i10
I
i2
i6
F'
I2
k16
i5
k15
k17
k
k''
kx
k20
N
n
I3

Fig. 20a.


i10
i7
i7
I3
i7
I

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GRAPHOPHONE RECORD DUPLICATING MACHINE.

(Application filed Aug. 16, 1898.)

II Sheets—Sheet II.

(No Model.)

Fig. 24.

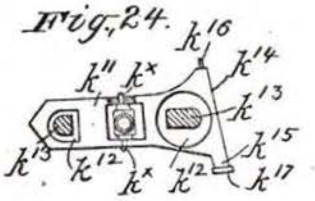
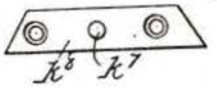
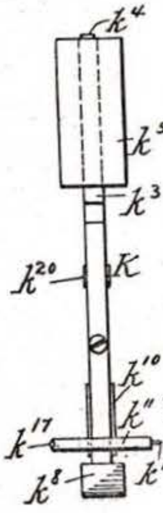
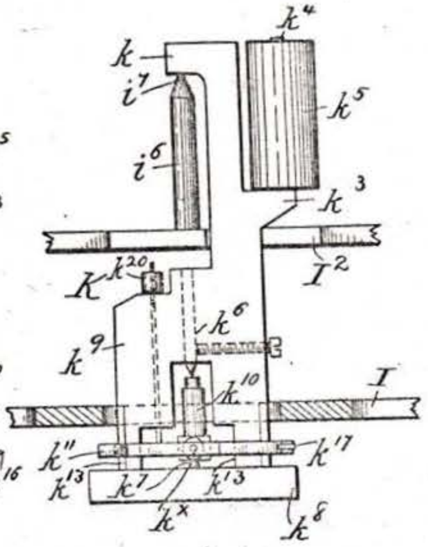

k16
k11
kx
k14
k13
k13
k12
kx
k12
k15
k17

Fig. 25.




k4
k5
k3
k20
K
k10
k11
k17
k16
k8


k
i7
k4
k5
i6
k3
I2
k20
K
k6
k9
k10
I
k11
k17
k13
k7
k13
kx
k8

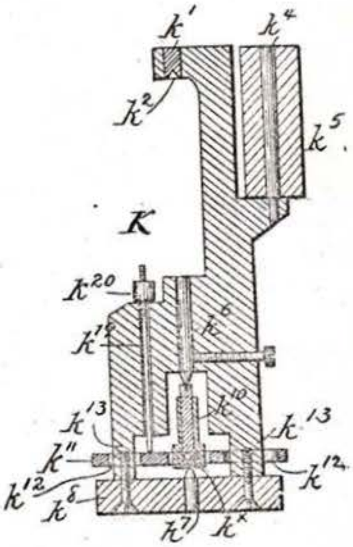
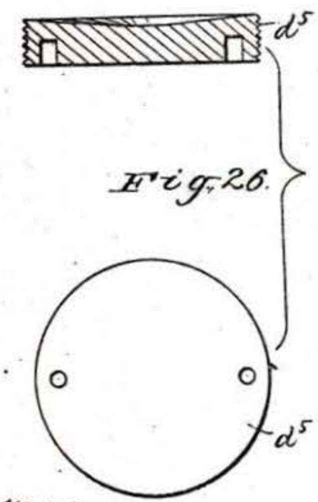
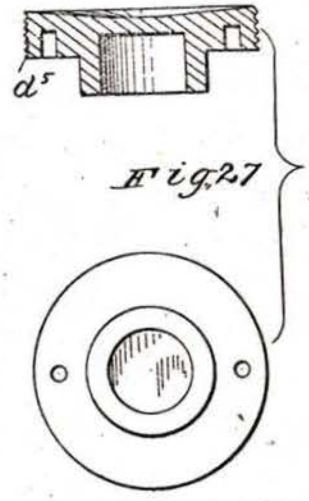

k1
k4
k2
k5
K
k20
k15
k6
k13
k10
k13
k11
k12
k12
k8
k7
kx

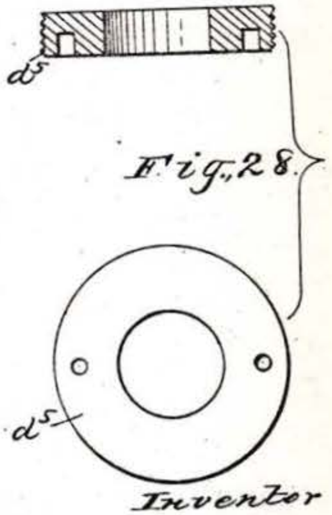
Fig. 22.

Fig. 21.

Fig. 23.







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UNITED STATES PATENT OFFICE.

CHARLES SUMNER TAINTER, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO THE AMERICAN GRAPHOPHONE COMPANY, OF SAME PLACE.

GRAPHOPHONE-RECORD-DUPLICATING MACHINE.

SPECIFICATION forming part of Letters Patent No. 670,442, dated March 26, 1901

Application filed August 16, 1898. Serial No. 688,717. (No model.)

To all whom it may concern:

Be it known that I, CHARLES SUMNER TAINTER, of Washington, District of Columbia, have invented a new and useful Improvement in Machines for Duplicating Graphophonic Sound-Records, which improvement is fully set forth in the following specification.

My invention relates to the art of duplicating sound-records for graphophones or talking-machines.

Most of the sound-records sold on the market at the present time are not the original sound-records formed by the vibrations of a cutting-style attached to a diaphragm upon which the sound-waves are caused to impinge, but are copies or "duplicates" of the records thus originally made by the direct action of the sound-waves. In the manufacture of such duplicates an original sound-record is first formed by causing the sound-waves to be recorded to impinge upon a vibrating diaphragm bearing a cutting-style whose point is embedded in the surface of a suitable recording-tablet. A record thus formed by the direct action of the sound-waves is known in the art as an "original" sound-record. This original record and a blank tablet are then mounted to revolve parallel to each other, and a follower with a fine blunt edge is caused to track in the record-groove and is connected by a suitable lever to a cutting-style whose point is embedded in the blank tablet. The blunt edge of the follower in the original sound-record rubs over the bottom of the undulatory groove constituting such record, and thus impresses upon the cutting-style whose point is embedded in the blank tablet vibrational movements exactly corresponding to the waves or undulations in the groove constituting the original sound-record, thereby causing the cutting-style to duplicate in the blank tablet the undulating groove of the original. There is thus produced a duplicate sound-record which is in every way as perfect a record of the original sound-waves as is the original sound-record itself and one which may be and is used to reproduce the original sound-waves in conjunction with a reproducer on a graphophone exactly as is done with the original record. The duplicate may itself also be used as a master in the production of additional duplicates. This method of causing a sound-record, whether original or duplicate, to impress vibrational movements corresponding to the recorded sound-waves upon a cutting-tool or graver in contact with a record-tablet was patented to me in United States Patent No. 341,287, granted May 4, 1886, and an improved duplicating-machine operating in accordance with said method is shown in United States Patent to Macdonald, No. 559,806. Such machines are efficient in operation and produce accurate and satisfactory duplicate sound-records; but as they can make but one duplicate at a time it is necessary where a large number of duplicate records are to be made to employ a large number of duplicating-machines and workmen for operating the same.

The object of my present invention is to provide a duplicating-machine which shall be capable of simultaneously making a plurality of duplicate sound-records from a single master-record, thereby rendering it possible to largely increase the production of a factory over that obtained by the machines now in use and without any corresponding increase in the number of machines or in the operatives therefor.

To this end my invention, broadly stated, consists in means for simultaneously revolving a master-record and a plurality of blank tablets arranged in proximity thereto, each blank tablet having a cutting style or point embedded in its surface, which point is connected by a vibratory lever to a rubbing-style tracking in the record-groove of the master.

The invention further consists in mechanism for duplicating in a plurality of blank cylindrical tablets arranged in a vertical position a sound-record on or in a master-tablet, also operating in a vertical position, in which mechanism a series of rubbing-styles tracking in the record-groove of the master are connected to cutting-styles embedded in the blank tablets, the rubbing and cutting styles being yieldingly held in their proper operative positions by gravity or equivalent spring action, whereby errors due to irregularities in the surfaces of the tablets are avoided.

The invention also consists in certain details of construction which will be hereinafter fully described and then pointed out in the claims.

I have illustrated one form which my invention may assume in the accompanying drawings, in which—

Figure 1 is a front elevation of my duplicating-machine, parts being removed. Fig. 2 is a vertical section, parts being in elevation. Fig. 3 is a top plan with some of the transferring-levers omitted. Fig. 3^a is a broken detail showing means for oiling the driving-pulley shafts. Fig. 4 is a top plan of the steadying-block. Fig. 5 is a vertical section on the line 5 5, Fig. 4. Fig. 6 is a vertical section showing the connections for driving the screw-shaft. Fig. 7 is a bottom view of the bed-plate. Fig. 8 is a vertical section thereof. Fig. 9 is a top plan showing the means for removing the tablets from the mandrels. Fig. 10 is a horizontal section on the line 10 10, Fig. 2, looking upward. Fig. 11 is a vertical section of one of the mandrel-supporting columns. Fig. 12 is a top plan of the carriage-plate. Fig. 13 is a sectional detail showing the means for actuating the carriage from the feed-screw. Fig. 14 is a plan of the support for the transferring-levers. Fig. 15 shows a plan and side elevation of a ring for removing tablets from the mandrels. Fig. 16 is a view of the spider which supports the carriage, showing its connection to the screw-shaft. Fig. 17 is a bottom view of the same. Fig. 18 is a side elevation showing the cam-ring and coöperating parts for removing tablets from the mandrels. Fig. 19 is a horizontal section on line 19 19, Fig. 2, looking downward. Fig. 20 is an enlarged top plan of the carriage, some of the transferring devices being shown in position and others being removed. Fig. 20^a is a partial vertical section thereof. Fig. 21 is a side elevation of the swinging block supporting the lever connecting the rubbing and cutting styles, which block, together with all the parts supported thereby, is for convenience of description herein referred to as a "transferring device." Fig. 22 is an edge view of Fig. 21, and Fig. 23 is a vertical section thereof. Fig. 24 is a plan view of the transferring-lever and the rubbing and cutting styles connected thereby. Fig. 25 is a plan of the bottom part of the swinging block, and Figs. 26, 27, and 28 are views in section and plan of bottom pieces for the columns hereinafter referred to.

Referring to the drawings, A is a bed-plate mounted upon hollow standards or supports B, the lower ends of which are properly spaced by a three-armed spider C, having openings *c* formed in the arms, through which openings the hollow standards B pass and in which they are secured by set-screws *c'*, as shown. The bed-plate A has centrally formed therethrough an opening *a*, and around this opening *a* are a plurality of similar openings *a'*. I have shown six such openings *a'*; but more or less than six may be employed, if desired, and while it is preferable to arrange these openings symmetrically around the central opening *a* this is not absolutely necessary. In the central opening *a* through the bed-plate is secured a vertical column D, and in each of the openings *a'* similar columns D' project both above and below the bed-plate and are secured in place by means of screws a^2, passing downward through the bed-plate and engaging circumferential flanges *d* upon the columns D D', which flanges fit an annular recess formed on the under side of the bed-plate A. The columns D D' are shouldered, as shown at *d'*, (see Fig. 11,) and have a central bore d^2, which bore is expanded below the bed-plate A into the circular chamber d^3, having interior screw-threads d^4 cut near the lower end thereof. This chamber d^3 is closed by a bottom piece d^5, Figs. 2 and 6, having its upper surface preferably somewhat dished, and upon this dished surface rests a shaft E of column D, which passes up through the bore d^2 in the column and has bearing-surfaces *e e* in contact with the surface of the bore, but is cut away between its ends to reduce friction.

On the upper projecting ends of the shaft E is secured a hollow mandrel F, which extends downward around the column, the mandrel preferably tapering slightly from its lower to its upper end and being at its open lower end nearly flush with the shoulder *d'*.

On the lower end of the shaft E is a gear *e'*, secured in place by the sleeve e^2, which is forced up against the gear *e'* by a binding-nut on the end of the shaft, as shown.

Each of the columns D' has a shaft E', to which is secured a mandrel F' on its upper end and a gear e^3 on its lower end, the shafts E', mandrels F', and gears e^3 being in every respect like the shaft E, mandrel F, and gear *e'* and all the shafts E' except one resting upon dished bottom pieces exactly similar to bottom piece d^5 in column D. In the single case where the shaft E' is not supported by the dished bottom piece this piece has an opening d^6 formed therein, through which a conically-pointed shaft E^2 projects, its conical point entering a centering depression *e'* on the lower end of the shaft E'. (See Fig. 6.) The shafts E' and E^2 are coupled so as to turn together by a sleeve E^3, which is connected to the shaft E^2, preferably by a driving fit of the parts, the other end of the sleeve fitting loosely over the nut and sleeve e^2 on the shaft E' and having an open-ended slot e^5, into which projects a radial pin e^6 on the sleeve e^2. This construction enables the parts to be readily assembled by driving the sleeve E^3 onto the shaft E^2 and then slipping the sleeve and end of the shaft through the opening d^6 in bottom piece d^5, with the end of sleeve E^3

surrounding sleeve e^2 and the pin e^6 entering the slot e^5, while the conical point of the shaft E^2 enters the centering depression e^4 in the lower end of shaft E'. The shaft E^2 is passed through an opening in one arm of the spider C, its lower end resting in a bearing-block C', secured to the under side of the spider. A recess c^2 is cut in the upper surface of the bearing-block, at the inner end thereof, and a pinion e^7 is secured on the end of shaft E^2 and revolves in the recess c^2. The bottom piece closing the chamber d^3 of the central column D has a socket d^7 formed on the lower side thereof, and the upper end of a tube E^4 fits snugly in said socket and has its lower end secured by a set-screw in an opening at the center of the spider C. The tube E^4 has a slot $e^\times$, Fig. 2, extending throughout its length, and in each end is secured a collar or ring affording bearings for a screw-threaded shaft E^5, revolving within the slotted tube E^4. On the reduced lower end of the screw-shaft E^5, which projects below the spider C, is secured the pinion e^8, which is geared through the idler e^9 to the pinion e^7 on the shaft E^2.

Beneath the bed-plate A is a thick block F^2, Figs. 4, 5, and 19, having openings *f f'* therein, which enable it to be slipped up over the ends of the columns D D', which project below the bed-plate, the block F^2 being secured in place by means of set-screws f^2, Fig. 2, passing inward from the perimeter of the block against the columns D'. The openings *f f'* in the block F^2 are formed with great exactness both as to size and position, as it is a part of their office to exactly center the columns D D' and hold them so as to avoid any vibration of the mandrels supporting the tablets and also to insure the perfectly-accurate working of the gearing connecting the several shafts E' with the central shaft E, Fig. 19, it being desirable to avoid any backlash or other play between the parts that would interfere with perfect uniformity in the operation of the seven mandrels.

Holes f^3 are formed in the block F^2 intermediate the center of the opening *f* and the several openings *f'*, and a shaft f^4 is inserted from above into each hole f^3, shoulders f^5 on the shafts resting upon the upper surface of the block F^2 and supporting the shafts. Upon the projecting upper ends of the shafts f^4 are secured pinions f^6, each of which intermeshes with and forms a driving-connection between the gear *e'* in the shaft E and one of the respective gears e^3 on one of the shafts E'. (See Figs. 2, 3^a, and 19.) Each of the shafts f^4 projects below the block F^2 and carries a driving-pulley f^7, suitably secured thereto. It will be understood that the six pulleys f^7 are thus symmetrically arranged around the central column D, and each is arranged to drive a shaft which is geared to the central shaft E and one of the shafts E'. The pulleys f^7 are surrounded by a closely-fitting band or belt G, Fig. 10, preferably of elastic material, and a second belt G' passes around the band G and thence to any suitable source of power.

The operation of the device as thus far described is as follows: Power being applied to the belt G' it is communicated through the belt G to the pulleys f^7, the latter belt serving to distribute the strain with great evenness, to the end that the gears f^6 may act with perfect uniformity, and since the central gear *e'* on the shaft E is connected to each of the equal gears e^3 on the shafts E' it follows that the central mandral F and its surrounding six mandrels F' will all be smoothly and evenly driven at the same speed, and the shaft E^2, being coupled to one of the shafts E', turns with it and drives the screw-shaft E^5 through the gears on the end of said shafts and the idler e^9, connecting them.

Surrounding the slotted tube E^4 is a sleeve H, Figs. 1, 2, 13, and 17, to which is adjustably attached a spider H', having horizontally-extending arms *h'*. The sleeve H has a vertical slot *h*, Fig. 13, cut in one side, and opposite said slot *h* there is secured to the sleeve a block h^2, having a recess h^3 cut therein, within which rests a pair of nut-sections h^4, united at their outer extremities and having a spring-pressed pin h^5, entering an extension of the recess h^3. The block h^2 is located in a vertical slot h^6, cut in one of the arms *h'* of the spider H', and a cam-ring h^7 surrounds the sleeve H and passes between the nut-sections h^4, a lever h^8 being provided for shifting the cam. The nut is held at all times against the cam-ring by the spring pressing on the pin h^5, the nut-sections extending through the slot *h* in the sleeve H and the slot $e^\times$ in the tube E^4. When the cam-ring is in the position shown in Fig. 13, the nut-sections engage the screw-shaft E^5, revolving within the stationary tube E^4, being held in engagement by the spring, thereby causing the sleeve H to advance longitudinally along the tube E^4 and carrying with it the spider H; but when the cam-ring is shifted it throws the nut out against the tension of the spring, and thereby disengages the nut from the shaft.

I, Figs. 2 and 12, is a circular plate having the central opening *i* and six marginal openings *i'*, each of which is of a size to slip freely over the tablets borne by the mandrels F F'. Six slots i^2 are cut in the plate, one between each of the openings *i'* and the central opening *i*, and form when thus arranged a regular hexagon around the opening *i*. The plate I is located above the bed-plate A and has attached to it three rods I', forming legs, which pass down loosely through the bed-plate A, but outside of the block F^2, and rest with their shouldered ends i^3 in sockets h^9 in the ends of the arms *h'* of the spider H'.

I^2, Figs. 3, 14, and 20, is a hexagonal plate having its center removed, so as to form an opening corresponding to the central opening *i* in plate I, and having notches i^4 formed in its periphery. This plate I^2 is supported on pillars i^5, (preferably six in number,) attached to the upper side of the plate I, and bears six upwardly-projecting pointed standards i^6, each of which is secured thereto near one end of a notch i^4, as shown in Fig. 14. The sleeve H, spider H', plates I and I^2, together with their connecting parts, constitute a vertically-moving carriage, and this carriage, with the parts supported thereby, is counterbalanced by weights b, attached to cords or chains b', passing over pulleys b^2.

Passing upward through each of the slots i^2 in the plate I is a block K, Figs. 1, 20, and 21, hung to swing on the pointed standards i^6. There are six of such blocks K, and as they are all identical in construction a description of one will suffice for all. On the upper end of the block is a horizontally-projecting arm k, in which is secured a piece of hardened steel k', with a depression k^2, forming a bearing-surface for the tempered point i^7 of the standard i^6. Extending from the side of the block opposite the bearing-arm k is a lug k^3, on which is a pin k^4, and k^5 is a weight or weights having a bore therethrough in order that it may be slipped on over the pin k^4. A vertically-adjustable bearing-point k^6 (preferably of hardened steel) is secured in a lower arm k^9 of the block K, which arm projects horizontally beneath the plate I^2. Between the bearing-point k^6 and a similar point k^7 on a bottom piece k^8, attached to the block K, is a block or hub k^{10}, which turns freely on a substantially vertical axis. The lower arm k^9 of the block K is cut away, as shown, so that the hub k^{10} turns in a recess thus formed and supports a lever k^{11}, which is hung on a horizontal axis to the hub k^{10}. The lever k^{11} has openings k^{12} near its opposite ends, through which legs k^{13} on the block K freely pass, so that the lever k^{11} may turn to a limited extent on its horizontal axis $k^{\times}$ or with the block k^{10} on its vertical axis. That end of the lever k^{11} which extends out under the weight k^5 is broadened into projecting points or arms k^{14} and k^{15}. A rubbing-style k^{16} is secured in the arm k^{14}, and a cutting-style k^{17} is fastened to the arm k^{15}, as clearly shown in Figs. 20 and 24, that end of the lever k^{11} supporting the styles being slightly heavier than the opposite end, so that if left free to turn about its horizontal axis the style-bearing end of the lever k^{11} would be depressed. A pin k^{19} fits loosely in the arm k^9 and has a small weight k^{20} on its upper screw-threaded end, the pin k^{19} extending down through the arm k^9 and bearing on that end of the lever k^{11} opposite the styles. The mass of the weight k^{20} is sufficient to overbalance the lever k^{11}; but by adjusting the weight k^{20} on the pin k^{19} it may be caused to bear upon that end of the lever k^{11} opposite the styles until the lever becomes horizontal, at which point the weight k^{20} is taken by the upper face of the arm k^9 of the block K. By this means the lever k^{11} is held yieldingly in a horizontal position, while the end bearing the rubbing and cutting styles is left free to move so as to accurately follow the record-groove in the master-record or respond to inequalities in the tablets.

Referring now to Fig. 20, the lever k^{11} is so proportioned and the rubbing and cutting styles so positioned thereon that the styles each come in contact with their respective tablets at the point where a line drawn through the vertical axis of the lever k^{11} is tangent to the tablet, the result being that the vibrations of both the rubbing and the cutting styles are substantially on radial lines of their respective cylinders, which is the direction along which said vibrations should occur for the production of the best results. By reason of the pendulum-like action of the block K the styles automatically find their proper position and are held to their work by the weight k^5, the mass of which is adjusted to a nicety to the end that it may yield sufficiently to allow the styles to conform to irregularities in the contour of the tablets and at the same time effectively prevent the styles from leaving the surfaces of the tablets. By thus mounting the style supporting and controlling lever so that it is free to turn about a universal joint and holding it to its work by the action of gravity I give to it all the sensitiveness and accuracy, when acting in conjunction with vertically-disposed tablets, that the well-known "floating" or "gravity" recorders and reproducers of the graphophone possess when acting to record or reproduce a record on a horizontally-disposed tablet.

In action the carriage bearing the rubbing and cutting styles, as described, is placed in its lowermost position and is elevated by the feed-screw E^5 at the same time that the mandrels are revolved. The result is that the records are cut in a spiral line starting at the bottom and ending at the top, so that when the records are completed the carriage, with its transferring-blocks and their supported styles, is at the top. In order to remove the records, it is necessary that the carriage be depressed, and before this is done it is essential that the styles be shifted so that they will not come in contact with the records during the downward movement of the carriage. For this purpose a ring I^3 is mounted on the plate I and is preferably of equal diameter therewith. This ring I^3 bears with its inner circumference on loosely-turning rollers i^7, secured to the plate I in position to center the ring I^3 thereon. Slots i^8 are cut in the ring I^3, and screw-pins i^9 are passed therethrough into the plate I, so that the ring I^3 has a limited circular movement upon the plate I. Secured to the ring I^3 are six spring-arms i^{10}, extending inward from the ring to the pendulous blocks K. When the styles are in operation, the inner ends of the arms i^{10} are adjacent to but not quite in contact with that edge of the respective blocks K which is opposite to the styles, (see Figs. 3 and 20,) and by shifting the ring

I^3 from left to right the spring-arms will simultaneously strike upon and swing the pendulous blocks K to the right, and thus throw all the rubbing and cutting styles out of contact with their respective tablets. The lower ends of the blocks K are shaped as shown in Fig. 25, and when the blocks are hanging in operative position said lower ends together form a nearly-closed regular hexagon; but as the movements of the blocks under the action of the spring-arms are simultaneous they do not in the swinging movement above described interfere with each other. The blocks being swung aside, the carriage may be lowered without danger of injury to the records from the styles, and the records being removed and new tablets placed on the mandrels the styles may be returned to their active positions by shifting the ring I^3 from right to left, the weights k^5 promptly throwing the styles in contact with their respective tablets.

In order that the tablets may be readily removed from the mandrels, I provide a means whereby they may be raised and, because of the slightly-conical form of the mandrels, loosened, thereby placing them where they may be readily grasped by the fingers and lifted from the machine. I provide the block F^2 with a flange $f^{\times}$, and resting upon this flange and turning freely around the block is a cam-ring L, having formed in its upper edge cam-surfaces l. There are three such cam-surfaces shown, each extending from its lowermost point to the top of the ring L, where they run into flat surfaces l^2. Normally resting upon said flat surfaces is a plate L', having lugs l^3 on its under side and resting in the cams l. The plate L' is perforated to allow the lower tubular portions of the columns D D' to pass therethrough, but is otherwise a solid plate. (See Fig. 9.) Any suitable handle l^4 is attached to the cam-ring, whereby it may be given about a one-third revolution, which causes the lugs l^3 to travel up the inclines or cams l and rest upon the flat surface at the top of the cam-ring, thereby raising the plate L through a distance equal to the rise of the cams l. Surrounding the base of each one of the columns D D' and resting on the bed-plate A is a ring or collar M, Fig. 1, dotted lines, and Figs. 2, 3, 15, and 18, whose internal diameter but slightly exceeds the external diameter of the mandrel on the columns, as clearly shown in Fig. 2. This ring M has a horizontally-extending base or flange m, in the form of a regular hexagon, so proportioned that when the several rings M are in place around the columns D D' the hexagonal flanges m meet and form, in effect, a complete and continuous flooring over all the space on the bed-plate between and around the columns, as is clearly indicated in dotted lines, Fig. 3. If desired, the flanges of the several rings might be united into one integral plate and the rings made separate therefrom and allowed to rest loosely thereon.

Passing loosely through the bed-plate A and resting upon the plate L are a number of pins m', whose length is just sufficient to reach from the top of the plate L when in its lowermost position to the top of the bed-plate A. These pins m' are clearly shown in Fig. 18, where the bed-plate A is omitted for the purpose of more clearly illustrating their operation and their relative distribution, whereby when the pins m' are raised above the bed-plate, as hereinafter described, they will press equally against all the flanges m of the rings M, and thereby lift them evenly and smoothly from the bed-plate, as shown in Fig. 9. Referring now to Figs. 1, 2, and 18 and assuming the parts to be in the position shown in Fig. 2, with tablets on the mandrels and the cam-ring L shifted to the right, with the plate L' resting upon the flat surfaces l^2 and the lugs l^3 in the lowermost parts of the cams l, it will be seen that the upper edges of the rings M are immediately beneath the lower ends of the mandrels and that the pins m' rest upon the plate L', with their ends flush with the top of the bed-plate A. If now one of the handles l^4 be grasped and the cam-ring L be shifted to the left, the lugs l^3 will ride up the inclines or cams l, forcing up the plate L', which in turn raises the pins m', and through them the flanged rings M, which latter engage the lower ends of the tablets and force them upward. The mandrels are slightly tapering toward the top, and the upward movement of the tablets so loosens them that they may be readily removed. When the cam-ring is given its full throw to the left, it will have turned through nearly one-third of a revolution, and the lugs l^3 will then rest upon the flat surfaces l^2 at the top of the cam-ring, thereby securely retaining all the parts in their elevated position while the tablets are being renewed, after which the cam-ring is again shifted to the right preparatory to placing other tablets upon the mandrels.

The carriage supporting the pendulous levers K is guided in its up-and-down movements by ears or lugs n, embracing uprights N, firmly secured on the bed-plate A, and the weights b in the hollow standards B are so proportioned that their combined mass is just sufficient to counterbalance the carriage, with all its supported parts, to the end that the work of the screw E in elevating the carriage may be reduced to the minimum. A further result of this construction is that the carriage will remain stationary in any position in which it may be placed.

The parts of the mechanism needing lubricating are very few, and I have provided means whereby lubrication may be readily accomplished. Referring to Fig. 2, d^7 is a small hole in column D, extending inward from the surface of the column under the ring M and then downward till it enters the chamber d^3, just inside the wall of the chamber. Oil entering this hole 27 at the top passes down into the chamber d^3 and along the walls thereof to dished bottom d^5, where it acts to lubricate the bearing of the shaft E on said bottom. A similar means is provided for oiling all the shafts E', except the one shown to the left of Fig. 2, where it is omitted, because in that instance the shaft does not rest upon the dished bottom piece that passes therethrough. The lower bearing *e* of the shafts E E' is lubricated through a hole d^3 in a manner that will be readily understood.

In order to lubricate the shaft f^4 of the driving-pulleys f^7, I pass a small tube *p* down through the bed-plate A, which tube registers with a longitudinal bore *p'*, extending from the top of the shaft f^4 downward in a vertical direction for a short distance and then outward to the periphery of the shaft. By lifting the rings M the tube *p* may be filled with oil, which will slowly find its way through the bore *p'* to the bearings of the shaft f^4.

I have shown at T, Fig. 10, a means for tightening the belt G, which will be readily understood.

It will be understood that while I have specifically and in detail described the best form known to me which my invention may assume, I have done so only that the invention might be thoroughly understood and not as indicating that the invention is limited to the specific construction shown, as the generic inventive idea may be embodied in different specific mechanical forms, and all such are meant to be included by the terms of my claims.

Having thus described my invention, I claim—

1. In a machine for duplicating sound-records the combination, with a tablet having a record formed therein and a plurality of tablets for receiving records, of a plurality of followers rubbing over the record, and a plurality of cutters each of which is movable with one of the followers, and each of which is embedded in the surface of one of the blank tablets, and mechanism for revolving the tablets and causing the followers to simultaneously follow the record and the cutters to simultaneously trace a spiral line upon the blank tablets, whereby a plurality of duplicate sound-records may be simultaneously formed from a single master-record, substantially as described.

2. In a machine for duplicating sound-records the combination of a revolving tablet having a sound-record therein, with a plurality of revolving blank tablets, a plurality of followers rubbing over the record, a plurality of cutters each of which is movable with one of the followers and each of which is also embedded in the surface of one of the blank tablets, gravity-controlled devices yieldingly holding the followers and cutters in contact with the respective tablets, and mechanism for revolving the tablets and causing the followers to simultaneously follow the record and the cutters to simultaneously trace a spiral line upon the blank tablets, whereby a plurality of duplicate sound-records may be simultaneously formed from a single master-record, substantially as described.

3. In a machine for duplicating sound-records, the combination of a plurality of vertically-disposed revolving mandrels, one of which bears a tablet having a sound-record formed therein and the others bearing blank tablets with a cutter embedded in the surface of each blank tablet, and a corresponding number of followers simultaneously rubbing over the record of the record-tablet, the cutters being mounted to partake of all the movements of the followers, substantially as described.

4. In a machine for duplicating sound-records the combination of a plurality of vertically-disposed revolving mandrels, one of which bears a tablet having a sound-record formed therein and the others bearing blank tablets, with a cutter embedded in the surface of each blank tablet, a corresponding number of followers simultaneously rubbing over the record of the recording-tablet, the cutters being mounted to partake of all the movements of the followers, and gravity-controlled devices yieldingly holding the followers and cutters in contact with the respective tablets.

5. The combination with a sound-record formed in a vertically-disposed tablet, of a vertically-disposed blank tablet, a gravity-controlled follower rubbing over the sound-record, a cutter embedded in the surface of the blank tablet and movable with the follower, and means for revolving the tablets and causing relative longitudinal movement between the tablets on the one hand and the cutter and follower on the other hand, substantially as described.

6. In a machine for duplicating sound-records, the combination of a vertically-disposed revolving master-record, and a plurality of vertically-disposed revolving blank tablets, with a plurality of followers, a plurality of cutters each one of which is movable with one of the followers, and gravity-controlled devices holding the followers and cutters, yieldingly in contact with the master-record and blank tablets respectively, substantially as described.

7. In a machine for duplicating sound-records the combination of a vertically-disposed mandrel bearing a master-record, a plurality of vertically-disposed mandrels each bearing a blank tablet and each independently geared to the mandrel bearing the master-record, with a vertically-moving carriage bearing a plurality of followers and a like number of cutters each of which is movable with one of the followers, and a plurality of gravity-controlled devices each of which holds a single follower and its coacting cutter yieldingly in contact with the master-record and with one of the blank tablets respectively, substantially as described.

8. In a machine for duplicating sound-records, a master-record, a plurality of blank tab-

lets, and a plurality of pendulous levers, each lever supporting a follower in contact with the record and a cutter in contact with one of the blank tablets, whereby a plurality of duplicate sound-records may be simultaneously formed from a single master-record, substantially as described.

9. In a machine for duplicating sound-records a master-record, a plurality of blank tablets, a plurality of pendulous levers, each lever supporting a follower in contact with the record and a cutter in contact with one of the blank tablets, and means for simultaneously throwing all the followers and cutters out of contact with the record and tablets, substantially as described.

10. In a machine for duplicating sound-records, a vertically-disposed master-record, a plurality of blank tablets, a plurality of pendulous levers, each lever supporting a follower in contact with the record and a cutter in contact with one of the blank tablets, and a vertically-movable carriage supporting said pendulous levers, substantially as described.

11. In a machine for duplicating sound-records, a central, vertically-disposed mandrel, a plurality of mandrels surrounding said central mandrel and each geared thereto, combined with a screw-shaft, a vertically-movable carriage, a lever supported upon said carriage and capable of movement about a universal joint, a follower and a cutter each attached to said lever, and nut-sections connecting said carriage to said screw-shaft, substantially as described.

12. In a machine for duplicating sound-records, a vertically-disposed mandrel carrying a sound-record, a plurality of vertically-disposed mandrels each having a blank tablet, a vertically-movable, counterpoised carriage supporting a plurality of followers in contact with the record, a plurality of cutters each movable with a follower and each in contact with a blank tablet, and means for revolving all the mandrels and giving translatory motion to the carriage, substantially as described.

13. In a machine for duplicating sound-records, a vertically-disposed pendulous lever, a follower connected by a universal joint thereto, and a cutter movable with said follower, substantially as described.

14. In a machine for duplicating sound-records, a pendulous lever, a block attached thereto and turning on a vertical axis, a lever supported by said block to turn on a horizontal axis, and a follower and cutter connected to said last-mentioned lever, substantially as described.

15. In a machine for duplicating sound-records, a bed-plate, suitable supports therefor, vertically-disposed columns mounted in openings so as to project above and below said bed-plate, shafts taking bearing in said columns and projecting therefrom above and below, mandrels secured to the upper ends of said shafts and gears to the lower ends thereof, and means connecting all the gears to a common source of power, whereby the mandrels are all simultaneously revolved, substantially as described.

16. The combination of a plurality of shaft-supporting columns mounted on a bed-plate with a centering and steadying block supported by said columns, substantially as described.

17. The combination of a plurality of mandrels for carrying record-tablets, a series of rings or collars capable of longitudinal movement along said mandrels, a cam-ring, and devices interposed between the same and said rings or collars, whereby the turning of the cam-ring will produce the longitudinal movement of the rings or collars, substantially as described.

18. In a machine for duplicating sound-records, a plurality of mandrels supporting a sound-record and a plurality of blank tablets, a plurality of pendulous levers supporting a plurality of followers in contact with the sound-record and a plurality of cutters one in contact with each blank tablet, a plurality of arms one in proximity to each pendulous lever, and an adjustable support common to all the arms, whereby said arms may be thrown into contact with the pendulous levers and swing the same so as to carry the followers and cutters out of contact with the record and blank tablets, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

CHARLES SUMNER TAINTER.

Witnesses:
E. T. ROCKWOOD,
WM. P. MILLER.

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UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 615.
NATIONAL PHONOGRAPH CO. VS AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 682, 676.
NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 801, 668.

[Fourth Edition.]

Complainant Exhibit, Edison
British Patent No. 1644
of april 24, 1878.

A.D. 1878, 24th *April*. N° 1644.

Recording and Reproducing Sounds.

LETTERS PATENT to Thomas Alva Edison, of Menlo Park, in the State of New Jersey, United States of America, for the Invention of "IMPROVEMENT IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORD."

PROVISIONAL SPECIFICATION left by the said Thomas Alva Edison at the Office of the Commissioners of Patents on the 24th April 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENT IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORD."

My present improvements are for more fully developing and perfecting the device heretofore invented by me, and known as the "phonograph." By extensive experiment and research I have been enabled to obtain very perfect articulation and to produce a record in a convenient form for preservation.

The sound vibrations are made to move a point that by preference is a diamond or other very hard substance and of a peculiar shape. The sound vibrations in the atmosphere act upon a diaphragm or other body capable of motion, and the same moves the indenting point, and acts as a phonograph. The indented material is properly designated a phonogram, and it is preferably metallic. Sometimes tinfoil is used upon a grooved surface; sometimes a thin sheet or leaf of metal is placed upon a piece of paper having a surface of parafin or similar material. Sometimes the metallic surface is copper, and where a matrix has been made of steel or iron by electrotype deposit, or otherwise, upon the phonogram it may be hardened and used for impressing a sheet or roller of metal, and thereby the original phonogram can be reproduced indefinitely in metal that may be hardened and used for any reasonable length of time to utter the sentence, or words, or sounds phonetically.

The instrument or portion of the instrument that reproduces the sound from the

[*Price* 8*d*.]

phonogram I term a "phonet." In order to facilitate production, use, and preservation of the phonograms I employ a ring or margin of thick paper or pasteboard, caused to adhere to the foil or sheet by resinous substance; this is used as a gauge in placing the sheet in the instrument or replacing the same in the phonet. I find that a disc revolved by gearing, and a weight or spring, and the movement regulated by a fan or governor, is a convenient device for presenting the surface to be indented to the phonograph, and the phonograph is on an arm that swings towards and from the centre of the disc, and is guided by grooves or other convenient mechanism.

The phonet device takes the place of the phonograph device when the sounds are to be reproduced.

When the sheet of material is wrapped around a cylinder its edges are passed down into a slit and held firmly. Either the cylinder may be moved endwise by a screw, or the phonograph or phonet devices be moved along the cylinder, and where the same sound is to be reproduced periodically, as calling out the hours of the day in a clock, or reproducing the sounds of animals in toys, the phonet is to be brought to the place of beginning automatically.

The phonographic devices employed by me are preferably a diaphragm of metal, against which the sound vibrations act. Sections of rubber tube applied to the surface act as dampers to prevent false vibrations; pieces of felt or similar yielding material may be used for the same purpose, and a small delicate hoop of spring metal between the diaphragm and the indenting point renders the phonogram more perfect than it would be if the diaphragm acted upon the point direct. A similar effect is produced by a disc upon the arm that carries the point, said disc being so close to the diaphragm that the atmosphere will produce the vibrations. It is often advantageous to use a case between the mouth of the speaker and the diaphragm to gather or hold the sound, and in some instances the head of the speaker should be inserted into this case up through a hole in the bottom. The mouth-piece is sometimes slotted or perforated, and has irregular edges to re-inforce the hissing sounds, and sometimes a membrane of rubber or gutta percha is fitted to the teeth, and forms a bag between the lips and the diaphragm.

The disc upon the arm that carries the point as aforesaid may be acted upon by a magnet, and the current through a helix from a diaphragm, or the motion of the arm and points may serve to set up a secondary current through such helix in consequence of the motion given by the phonogram to the point. The arm carrying the point in this latter case should be magnetised.

The phonogram may be produced by the direct action of air concentrated to the spot by a funnel terminating with a small hole, the end of the funnel being almost in contact with the moving surface to be indented.

When the foil is perforated instead of indented it can be rolled up in the form of a horn or cylinder, and revolved, and the articulation result from air blown from the end of a small tube passing through the perforations as they are presented in succession. Leverage is sometimes employed between the diaphragm and the phonogram, either to lessen or increase the motion of the phonographic action in recording, or of the phonetic action in speaking, and for recording quartette, trio, and other characters of singing, two, three, four, or more phonographic devices are employed upon one cylinder or plate, and the sounds will be reproduced by corresponding phonets; or where singing is conveyed through tubes to one diaphragm the phonographic record will be the combined tones, and the reproduction by the phonet will be complete and correct.

I find that an arm at right angles to a diaphragm, with a point resting upon the phonogram, will reproduce the tones by the weight and leverage of the arm moving the diaphragm. The phonogram may be in the form of a disc, a sheet, an endless belt, a cylinder, a roller, or a belt, or strip, and the marks are to be either in straight lines, spiral, zig-zag, or in any other convenient form, so long as the apparatus is adapted to bringing the same into contact with the phonet or speaking part of the apparatus, and the reproduction of the phonogram from a matrix or copy in relief

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of an original phonogram may be made upon a belt, roller, cylinder, plate, or other convenient surface.

For amusement and instruction this phonograph is capable of extended use. For instance, a revolving cylinder containing phonograms of the letters of the alphabet and phonet keys, with corresponding letters on them, can be used in teaching the alphabet; and phonogram sentences, speeches, and other matters can be spoken by the phonet and repeated by the learner without the eyesight being called into use. For amusement or instruction the phonogram can be of a dog's bark, a rooster's crow, a bird's song, a horse's neigh, a lion's roar, and the like, and the phonogram can be used in a toy animal with a single phonet for the reproduction of the original sound.

This phonograph or speaking machine applied to a mask produces a semblance of vitality if the phonogram is made to operate upon moveable lips by levers, and in the production of such a phonogram a portion of the surface is to be indented by delicate levers and points, receiving motion from the lips during articulation; thereby a correct reproduction of the motion of the lips is obtained.

In connection with the phonet it is important to avoid the sound that usually results from the rubbing action of the phonogram upon the point. I am enabled to prevent this by an electric action between the point and the phonogram. In this case the phonogram should be of iron, and the point of steel and the parts magnetised so as to slightly repel each other; the point will follow the undulations and reproduce the sounds by the phonet. It is important that the point used in the phonet correspond in shape to that of the phonograph, but slightly smaller, so as to follow the bottom of the depressions without contact upon the sides. The diaphragm or other body employed in the phonet to receive motion from the phonogram is connected with a funnel of paper or other resonant substance that acts as a sounding board to render the phonet louder and more distinct.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Thomas Alva Edison in the Great Seal Patent Office on the 22nd October 1878.

THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, United States of America. "IMPROVEMENTS IN MEANS FOR RECORDING SOUNDS, AND IN REPRODUCING SUCH SOUNDS FROM SUCH RECORD."

This Invention consists in means for recording in permanent characters the sounds made by the human voice in speaking and singing, those made by musical instruments, birds, animals, or any sound whatever, and in means for reproducing those sounds at any desired time.

The sound vibrations act upon a diaphragm or other body capable of motion; this diaphragm is at the back of a chamber provided with an opening or mouth-piece, and to this diaphragm an indenting point is secured. This instrument I term a "phonograph." The phonograph is adjusted to position with its indenting point contiguous to a moving surface covered with a thin sheet of metal foil or other suitable material, or else the surface with the metal foil is stationary, and the phonograph movable. The surface upon which the metal foil is secured is by preference grooved spirally, and this indenting point indents the foil in the line of this groove as the diaphragm is moved back and forth by the sound vibrations; these indentations are a record of the sound waves, and form the characters for reproducing the sounds. This indented sheet I term a "phonogram." The instrument or portion of the instrument that reproduces the sound from the phonogram I term a "phonet." It is similar in construction to the phonograph, being provided with a diaphragm and point, but the mouth-piece is by preference funnel-shaped to render the sound loud and distinct. The sounds are reproduced by the phonet being adjusted to place so that the point of its diaphragm is at the beginning of the spiral line of indentations, and as the surface containing the indented foil is moved the diaphragm of the phonet is vibrated by the point passing from one indentation to the next, hence the diaphragm receives the same movement from the indentations as when making those indentations, consequently the sounds made by the phonet will be the same as those that operated upon the diaphragm of the phonograph.

In the Drawing Fig. 1 is a section of the phonograph and sectional elevation of the mechanism for presenting the surface to be indented; and Fig. 2 is a plan of the same.

The phonograph is made of the body portion a, diaphragm b, and indenting point c. The body portion a has a central opening forming the mouth-piece into which the person speaks, or through which opening the sound vibrations pass to act upon the diaphragm, and the diaphragm is secured at its edges to the body a, leaving a space between the body and diaphragm in order that the diaphragm may vibrate freely. The indenting point should be a diamond or other very hard substance. The diaphragm is made of a thin sheet of iron or other material, and it is preferable to place the indenting point upon a delicate spring arm e^2, and to employ a short piece of rubber tubing e^3 between the spring and diaphragm; this rubber acts as a damper to prevent false vibrations of the diaphragm. The phonograph is upon a lever arm i pivoted at 5 to the vertical stud 6, so that the phonograph may be raised or lowered vertically, or moved horizontally for a purpose hereafter explained.

It is now to be understood that if a person speaks with his mouth near the mouth-piece of the phonograph the sound vibrations will act upon the diaphragm, and vibrate it, and communicate to the indenting point a similar movement, and

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that if a piece of metal foil or other material susceptible of being indented is placed beneath or behind the indenting point and caused to move regularly, or the indenting point moved over the material, that said material will be indented and form a perfect record of the sound vibrations. I will now describe the means for sustaining the sheet to be indented, and the mechanism for moving the same:—*d* is a disk or plate secured to and turning with the shaft *e*, and hinged to this disk is a ring frame *f*; this disk *d* has two spiral grooves 3, 4, in its surface. There are pins 2, 2, upon the surface of the disk, and holes at corresponding places in the ring frame; the sheet to be indented is of a size and shape to correspond with that of the disk *d* and frame *f*, and said sheet has holes in it corresponding to the position of the pins 2, 2, and these holes form register marks in placing or replacing the sheet upon the disk *d*, and after the sheet is so placed the ring frame *f* is brought down upon the sheet and holds it firmly in place. There may be a central opening in the indented sheet of a size slightly larger than the space occupied by the spiral 3, and the outer edges of the sheet are stiffened by a ring of thick paper or pasteboard caused to adhere by glue or other adhesive material. The surface of the disk *d* is made with two spiral grooves 3 and 4 as aforesaid; the groove 3 is a guide for a pin that is upon an arm *g* on the phonograph, and the groove 4 is for the indenting point *c*. As the disk and sheet are revolved the groove 3 causes the indenting point to occupy a position immediately over the line of the spiral 4, and the indentations will be made upon the sheet of foil in a line corresponding to that of the spiral 4, shown in Fig. 2. The indentations made in the foil are a complete record of the sound vibrations that acted upon the diaphragm *b*, and from this indented sheet, which I term a "phonogram," the sounds are reproduced. The phonograph is carried outwardly by the spiral 3, and in so doing the parts swing upon the vertical stud 6. By depressing the outer end of the lever *i* the phonograph is raised so that it can be swung aside from the disk *d* to allow of the ring frame *f* being thrown back and the indented sheet or "phonogram" removed from the disk. The shaft *e* is revolved by a weight or spring, and gearing at *h*, and the spring is wound up by moving the lever *k* back and forth, which acts upon a ratchet and pawl of ordinary construction; *l* is a lever provided at its outer end with an inclined groove, in which is a pin on the lever *m*, and the other end of this lever *m* is connected with the coupler m^1 by moving the lever *l* one way or the other, the shaft *e* will be connected to or disconnected from the gearing *h*, and hence the disk *d* stopped or started at pleasure without interfering with the motor. As it is necessary that the shaft *e* should be revolved with uniformity I provide a governor at *n* to prevent the apparatus revolving too rapidly; and this may be made as in Figs. 1, 3, & 4, in which there are metal blocks *o* at the ends of spring arms from a cross head on a shaft that is driven by the gearing *h*, said blocks swinging radially and acting against the interior of a stationary cylinder *p* if the speed becomes too great, thereby checking the speed by the friction of the blocks against the cylinder. These spring arms may be secured at one end to a prismatic block as shown in Fig. 5. It is preferable to cover the surface of the blocks *o* next the cylinder *p* with felt or similar material that will slide upon the interior surface of the cylinder *p*, but produce more or less friction, according to the centrifugal action.

The guide spiral 3 may be dispensed with, and either of the devices shown in Figs. 6, 7, 8, or 9 made use of. In Figs. 6 and 7 the shaft *e* projects above the surface of the disk *d*, and there is a tooth upon the shaft contiguous to a rack bar extending from the phonograph, hence each revolution of the shaft, the rack bar, and phonograph will be moved the space of one tooth, consequently the lines of indentations will be parallel and concentric to the shaft *e*, excepting at the places when the tooth acts to move the rack bar and phonograph outward or inward. In this case the spiral grooves are cut to correspond to the feed. In Fig. 8 a worm upon the shaft *e* acts upon a worm pinion to revolve the shaft e^5, and the worm at the other end of this shaft e^5 acts upon teeth around the base of the lever *i* on the stud 6. By this device the phonograph will be moved outward gradually, and the line of indentations will be in a spiral corresponding to the continuous spiral groove in the plate *d*.

In Fig. 9 the shaft *e* is made with a fusee at p^1, and one end of a swinging arm connected to the phonograph takes against the same. The spirals of the fusee gradually move outward the phonograph, as the disk and shaft are revolved, and the line of indentions will be spirally the same as that made by the spiral 3.

In Fig. 10 the shaft *e* is provided with a screw pinion meshing with teeth upon a cam wheel 7. This gives the same movement to the phonograph as the spiral groove 3.

In Fig. 11 the guide groove 3 for the arm and pin *g* is upon a disk d^1 upon the shaft *e*, but the groove 3 occupies the same relative position upon the disk d^1 as the groove 4 upon the disk *d*, so that the phonograph is moved outwardly by the groove of the disk d^1, swinging both the arms *g* and *i* upon the vertical pivot 6.

Instead of the sheet of metal foil being upon the disk *d* it may be wrapped upon a cylinder *q*, as in Fig. 12. In this case the cylinder is upon a shaft e^1 revolved by the gearing at h^1, and upon said shaft there is a right and left hand screw at k^1, and there is a corresponding double spiral groove in the surface of the cylinder *q*. The phonograph is secured to a sliding shaft l^1, and said shaft is moved endwise back and forth by the screw k^1 acting upon an arm m^2 that is secured to the said shaft l^1. As the phonograph is moved in one direction the line of indentations is made spirally in the foil on the cylinder *q*, and when the arm m^2 reaches the end of the screw it will be moved in the other direction by the reverse screw thread, and the phonograph will make a second spiral line of indentations that will cross the first spiral line. This feature is especially available for a phonet where the surface of the cylinder *q* is formed of an electrotype or other copy of the phonogram, so that the words or sounds may be reproduced automatically and at intervals if desired. It is preferable to make use of a thin metal plate n^2, see Figs. 13 and 14, pivoted at one end and fitting within a longitudinal groove in the surface of the cylinder *q* for securing the edges of the metal foil and holding it securely upon said cylinder. The top of this plate n^2 is flush with the surface of the cylinder, and grooved to correspond with the grooves in the cylinder, so as not to interfere with the indenting point. A wire may replace this device, such wire being secured by arms at each end of the cylinder, and raised and lowered in and out of the groove by a cam or otherwise. I find that an interruption of one-eighth of an inch space where there is no recording is not detected by the ear.

The apparatus shown in Figs. 13 and 14 is similar to that shown in Fig. 12, except that the phonograph is stationary and the cylinder moves horizontally, and the shaft e^1 is only provided with a screw thread in one direction, hence the cylinder will have to be moved back by hand to bring it to place if desired to reproduce the sounds from the phonogram, or to position the phonograph if a new sheet of foil is to be indented after the first one has been removed. This is readily accomplished by raising the arm o^1 and its tooth from the screw k^1, which leaves the shaft e^1 and cylinder free to be moved back and forth. In Fig. 15 the phonograph is fitted to move horizontally instead of the cylinder *q*, as in Fig. 12, but the shaft e^1 is provided with a screw thread in one direction only, hence the phonograph has to be positioned by hand after the arm o^1 has been raised from the screw k^1. In Figs. 12 and 15 the phonograph can swing upon the shaft l^1 to raise the indenting point from the cylinder *q*, and allow for the removal or insertion of a sheet of foil, and there is a stop at 8 for adjusting the position of the phonograph when brought down to indent the foil.

In Figs. 13 and 14 the phonograph is upon an arm pivoted at 9, so that it can be swung horizontally away from the cylinder *q* for the purpose aforesaid, and the adjustable stop 8 is also provided.

Thus far I have described the "phonograph" or instrument upon which the sound vibrations act, and which instrument acts to indent the sheet of foil and produce the "phonogram" or record of such sound vibrations. Mechanism has also been described for presenting the sheet of foil to be indented by the phonograph.

I will now describe how the sounds are reproduced from the phonogram. If it is desired to reproduce the sounds from the phonogram in the same instrument in which the phonogram was produced it is only necessary that the indenting point *c* be made to traverse the line of indentations in the phonogram, and that a funnel-shaped mouth-piece, shown by dotted lines in Fig. 1, be added to the phonograph to aid in increasing the loudness and distinctness of the sound. The instrument in this form I term a "phonet."

In the instrument shown in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, 14, and 15, the phonet requires to be positioned by hand, as before explained, in order that the point *c* may be placed at the beginning of the spiral line of indentations. As the point *c* passes from one indentation to the next, either by the foil being moved beneath said point, as in Figs. 1, 2, 6, 7, 8, 9, 10, 11, 13, and 14, or by the point moving over the foil, as in Figs. 12 and 15, the diaphragm *b* receives a movement corresponding to the depth of the indentations, and corresponding also with the same movement it received from the sound vibrations when making those indentations, hence air waves will be produced by the movement of the diaphragm that will make sounds by passing through the mouth-piece of the phonet that will be exactly the same as the sounds that acted upon the diaphragm of the phonograph.

The material upon which the record is made may be of metal foil, such as tin, iron, copper, lead, zinc, cadmium, or a foil made of composition of metals. Paper or other materials may be used, the same being coated with parafine or other hydrocarbons, waxes, gums, or lacs, and the sheet so prepared may itself be indented, or the material, say paper, may be made to pass through a bath of hot parafine and thence between scrapers. Thin metal foil is now placed on the material, and the sheet passed through rollers, which give it a beautiful smooth surface. The indentation can now be made in the foil, and the parafine or similar material, and the indenting point, does not become clogged with the parafine in consequence of the intervening foil. If the copper foil, or tin foil with copper surface is used, and a matrix of iron or steel made by electrotype deposit or otherwise upon the phonogram, such matrix may be hardened and used for impressing a sheet or roller of metal as hereafter mentioned; thereby the original phonogram can be reproduced indefinitely in metal that may be hardened and used for any reasonable length of time to utter the sentence or words or sounds phonetically.

I will now briefly describe some modifications in the construction and operation of the phonograph and phonet.

In Fig. 16 the indenting point *c* is upon a spring arm e^2, as in Figs. 1 and 2, but there are short sections of rubber tube e^8 at each side of the diaphragm *b* to dampen the diaphragm and prevent false vibrations. In Fig. 17, the rubber of the diaphragm acts against the outer end of the arm e^2 to increase the leverage and lessen the depth of indentations in the foil and allow of the record being made in less yielding material than tin foil. Fig. 18 shows a modification of the last-mentioned device, the pressure being applied to the arm e^2 between the indenting point and the support for the arm so as to increase the depth of the indentations. Fig. 19 shows the arm e^2 made as a lever with a spring. Fig. 20 shows the indenting point upon the center of a spring bar that is firmly held at each end; the bar is connected at its centre to the diaphragm *b* by a string or otherwise. Fig. 21 represents the diaphragm *b* as of concave form instead of flat. Fig. 22 shows the indenting point upon a spring secured to the diaphragm.

Fig. 23 shows a disk upon the spring e^2 of the indenting point; this disk is placed quite close to the diaphragm and is moved by the air as the diaphragm is vibrated, the disk being so close to the diaphragm that the two will vibrate together, as air cannot pass between or escape as rapidly as the vibrations take place.

Fig. 24 shows the diaphragm vibrated by electro-magnetism; in this case the diaphragm is to be of iron, and the power of the electro-magnet will be varied by a rise and fall of electric current passing through the helix of the elecro-magnet; this rise and fall of electric tension is to be produced by the action of sound upon a diaphragm and connections in an electric circuit. Fig. 25 shows the method of vibrating the indenting spring and point by the direct action of an electro-magnet without the use of a diaphragm, the electric tension in the helix being varied by sound vibrations upon a diaphragm. Fig. 26 shows the spring arm e^2 connected to one end of a permanent magnet so as to highly magnetize the reproducing point; the foil should be of iron. When the point passes an indentation there will be less attraction than when passing no indentation; this will give good articulation free from the scraping noise of the point on the foil, for in this case it does not touch the foil, but is worked by magnetic attraction. Fig. 27 represents two instruments in connection with the cylinder q; in this case the phonet and the phonograph are separate. The phonograph records in the usual manner, but the phonet has its diaphragm set in motion by the rise and fall of the lever e^2. This reduces the scraping noise of the foil and acts by leverage, and a slight tension to move the diaphragm as the phonogram is moved beneath the point c. Fig. 28 shows an arrangement whereby four persons may speak simultaneously and have records made in separate parallel lines upon one cylinder, and the phonogram will reproduce the sounds the same as though it contained the record of but one voice. Fig. 29 shows a single phonograph adapted to receive the voices of three persons as in singing; the sounds made by the three voices are conveyed through flexible or other tubes to the diaphragm, and will be recorded in a single line of indentations. but when reproduced by the phonet the sounds uttered will correspond to the three voices.

In Fig. 30, the foil is sustained upon a hollow cylinder with a funnel-shaped end. The record is made upon the foil in the usual manner by the phonograph, excepting that holes are made entirely through the foil. A nozzle with a small opening is placed so that it will always be opposite the line of perforations as the cylinder is revolved. This nozzle is connected to a source of compressed air or other fluid, and every time a perforation comes opposite the nozzle, a puff of air passes into the cylinder and a sound is produced upon the principle of the siren. The nozzle may be placed on a spring to keep the end of the nozzle in contact with the line of perforations.

Fig. 31 shows the phonograph as made with a large chamber between the diaphragm and the mouth-piece; this is especially useful in collecting sound when the person speaking or the sound to be recorded is made several feet from the instrument. Fig. 32 shows a device whereby the indenting point may be dispensed with in the phonograph. The funnel forming the phonograph is made with a diaphragm at the larger end or mouth-piece, and a very small hole at the pointed end adjacent to the foil on the cylinder q; this foil should be very thin so that the indentations will be made by the direct action of the air waves as concentrated by the funnel without the interposition of the indenting point. Fig. 33 shows a phonet in which the phonogram or sound record has been made upon an endless belt; this is a convenient arrangement for toys, as the same may be made to imitate the bark of a dog or other noise made by an animal; and this belt may be of steel or other hard material that allows the same to be used for a long period of time.

Fig. 34 is a perspective view showing a double phonet, there being a spiral line of indentations on each side of the revolving disk d, one phonet coming into action as the other finishes; in this case the spirals should be in opposite directions, so that the disk continuing to revolve in the same direction moves one phonet from the center outwards, and then the other phonet is connected and moved back towards the center; this may be used as a toy.

Fig. 35 represents a phonet in which the phonogram containing a sentence, speech, words, or other sound record is upon a belt or strip wound upon a reel; this belt is drawn along gradually and wound upon the second roller by any suitable mechanism, and as the phonogram is thus moved it actuates the phonet *c*, *b*. Fig. 36 shows a phonograph or phonet similar to that shown in Fig. 12, the cylinder *q* is revolved, but remains in one position, and the phonograph or phonet is movable back and forth over the cylinder. In this instance the arm m^2 is extended beyond the screw k^1, and passes beneath the inclined spring guide m^5, when the screw is carrying the arm and phonograph towards the right: as the arm m^2 passes from beneath the end of the guide m^5 it is no longer held to the screw, and the arm m^2 and phonet are lifted by the guide m^2 as the springs m^3 draws the shaft, phonograph, and arm, along to the place of beginning, at which place the arm m^2 drops off the end of the inclined guide m^5 into the thread of the screw, and as this revolves it carries the arm along beneath the guide m^5 as before. Fig. 37 represents the phonograph or phonet upon a pivoted arm, so that it may swing across or at right angles to the line of movement of the intended material or phonogram. In this case the line of indentations may be lengthwise of the belt, or across the same in the arc of a circle. Fig. 38 shows a phonograph similar to that shown in Fig. 31, except that the sound chamber is of a different shape.

Fig. 39 shows a mouth-piece with an orifice of soft rubber to fit the mouth or the lips of the person speaking, so that all sound waves will be confined to the chamber and diaphragm. Fig. 40 shows the mouth-piece of the phonograph made with cross slots with irregular edges. Fig. 41 shows the mouth-piece as perforated with numerous holes. Fig. 42 shows but one opening in the mouth-piece; the edges of this are irregular. These irregular edges reinforce the hissing sounds, and cause a more perfect phonogram to be produced. Fig. 43 represents a mouth-piece of mica with a central opening protected at its edges by a wooden ring. In Fig. 44 the diaphragm *b* is of wire gauze with a backing of paper connected to it by any suitable cement, and there is a ring of stiff paper at the edges of the gauze disk to strengthen it. Fig. 45 represents a diaphragm *b* of parchment or similar material stretched tightly within the frame b^6 by cords and screws. The cords may be of different lengths and tension, and respond to and reinforce certain sounds. Fig. 46 shows a mouth-piece for the phonet made in imitation of the human mouth. Fig. 47 represents the body portion of the phonograph or phonet made triangular, and the diaphragm is of corresponding shape. Fig. 48 represents three cylinders, each provided with a phonograph or phonet; this is useful in recording and reproducing three-part singing or music. Fig. 49 represents a phonet made as a tube, with flaring or trumpet-shaped ends, and with two diaphragms 15, 16, placed crosswise of the tube so as to form an air chamber. There is a third diaphragm *b*, which is vibrated by the movement of the reproducing point *c*, and said diaphragm gives motion to the air in the chamber, and vibrates the diaphragms 15, 16, which latter produce air waves, and the sounds issuing from the two trumpet-shaped ends will blend and increase the volume of sound. Fig. 50 represents a device whereby deep indentations are made in the metal foil. Two diaphragms are employed, the first (b^2) is vibrated by the sound vibrations, and controls a valve b^7 in a tube connected with a source of compressed air or other fluid; this valve b^7 allows more or less air to pass to the diaphragm *b*, according to the vibration of the diaphragm b^2, hence the diaphragm *b* will vibrate in harmony with the diaphragm b^2, but it will be acted upon by greater force, and consequently the indentations will be deeper in the foil than if the diaphragm *b* was acted upon simply by the sound vibrations of the voice. Figs. 51 and 52 represent a device that may be used with a phonet to increase the loudness of the sounds reproduced. The sound vibrations from the phonet are conducted by a tube shown by dotted lines in Fig. 51, to the diaphragm b^3 that controls a valve b^7 in a tube connected with a reservoir of air or other fluid under pressure, and the air as it escapes by the valve passes into the trumpet-shaped end of the tube, and produces sounds that are very loud and clear, and are a reproduction of the sounds resulting from the use of one of the phonets before described. This same apparatus may be used to reproduce with louder utterances a person's voice, the sound from the voice being used to vibrate the diaphragm b^3, and thereby regulate the air waves escaping from the valve b^7 into the trumpet. Fig. 53 shows the speaker's head within a box or case; in this instance nearly all the sound vibrations act upon the diaphragm. Figs. 54 and 55 illustrate how the movements of the lips in speaking may be recorded and reproduced. In this instance, a lever applied to the diaphragm carries the indenting point *c*, Fig. 55, and the end of this lever is placed in the mouth of the speaker, and the movement of the lips regulates the indentations in the foil. A similar apparatus shown in Fig. 54 within a case is connected to the movable lips of a mask, so that these lips open and close as in articulation, at the same time that the sound vibrations are given by the phonogram to the phonet. Fig. 56 represents a toy phonet in which the phonogram strip 35 is secured at one end to a cylinder upon which it is wound. By pulling upon the strip it is unwound, and a rubber cord 37 is wound upon the shaft of the cylinder. When the hand is removed from the indented strip, the rubber cord rotates the shaft and winds up the phonograph upon the cylinder, and the sounds are reproduced in the phonet by the phonogram acting upon a point and diaphragm *a*. The movement of the shaft is regulated by the fan, worm, and pinion 38. In Fig. 57, the cylinder for moving the phonogram strip is shown as provided with pins that enter holes in the edges of the strip; this causes the strip to be fed along very regular. In Fig. 58, the cylinder with pins is shown as made with heads to act as guides for the strip. Fig. 59 shows a re-indenting device for amplifying or increasing the size of the indentations. There are two rollers, one of which a^4 travels faster than the other a^3, and there is a lever 40 pivoted at 41, and provided with a point *c* for each cylinder. One point follows the indentations in the cylinder a^3, and the other rests upon a^4, and as this travels the fastest, the indentations made therein will be longer and also deeper by the point being at the outer end of the lever. In Fig. 60, one roller 42 of the pair is made of hardened metal with the sound record in relief. This is obtained by electrotype or other process from an iron foil or other metal phonogram, and this roller is used to indent strips or sheets of foil or rollers to produce copies that can be used with the phonet. Fig. 61 represents a roller 42 of hardened metal with the record in relief, and arranged so as to knurl or indent the phonogram in a roller 43 of soft metal that is to be pressed against the roller 42 by a screw or other suitable means. The cylinder having a spiral groove in its surface may be made by placing the mould shown in Fig. 62 around a cylinder or shaft, and filling the space between the cylinder and mold with plaster of Paris or other suitable material. The mold is of metal with a screw or spiral rib projecting therefrom, and it is made in two parts and hinged so that it can easily be removed when the plaster of Paris is dry. For amusement or instruction, the phonograph is capable of extended use; for instance, a revolving cylinder, see Fig. 63, containing rows of indentations representing the letters of the alphabet, and provided with keys containing corresponding letters, can be used in teaching the alphabet, and sentences, speeches, and other matter can be spoken by the phonet, and repeated by the learner without the eyesight being called into use. Clocks may be provided with phonogram cylinders or wheels to call off the hours, to give alarms, &c. The phonogram may be upon a strip, sheet, belt, or roller, and it can be of a dog's bark, a rooster's crow, a bird's song, a horse's neigh, and these can be used in toy animals with a simple phonet for reproducing the sound. In copying phonograms, or making duplicates, an original phonogram may receive a deposit of copper or iron in a plating bath; and, if of iron, may be carbonized to convert it into steel and hardened, and then the same should be backed up with type metal, and use for impressing strips or pieces of metal.

A bed of gutta percha, or similar material, may be used to sustain the sheet metal while being pressed. Numerous copies of the original phonogram can thus be reproduced. A plaster cast can be used for producing a copy by pressure. The governor to regulate the speed of the instrument may be made of a pendulum weight 61, see Fig. 64, hung at the lower end of a rod that is provided with an universal joint at 62, and the upper end of the rod is moved around by a crank 63 that is revolved by the train of gearing. As the speed increases the weight will describe a circle of larger diameter, and thereby increase the resistance. The universal joint may be displaced by a spring wire, Fig. 65, that allows of the movement. A magnet 64 upon the crank arm 63, Fig. 66, may be use to revolve the pendulum by attracting an armature at the upper end of the pendulum rod, and thereby avoid the friction resulting from the contact of the surfaces of the pendulum rod with the crank. In Fig. 67 the diaphragm *b* is represented as connected to a pair of delicate piston valves within a tube 68 that has three ports; one 69, is connected to a reservoir of compressed air, the others, 70 and 71, are connected to a chamber 72 at opposite sides of a diaphragm, so as to vibrate the same in harmony with the diaphragm *b*, but there will be greater amplitude given to the same by the pressure of the air, and by a connection to the phonet diaphragm b^2 the sound produced will be greatly increased.

What I claim as my Invention is,—

First. The combination with the diaphragm and point of a flat receiving surface and means for revolving the receiving surface, and causing the point to follow a volute or spiral line, substantially as represented in Figs. 1, 2, 6, 7, 8, 9, 10, and 34.

Second. The combination with the revolving plate phonograph or phonet of a propelling weight or spring and a governor to regulate the speed, and ensure uniformity of movement, substantially as set forth.

Third. A revolving disk provided with a clamping frame to secure the foil or other material in combination with the swinging arm, diaphragm, and point, substantially as specified.

Fourth. In a phonograph or phonet, a spring introduced between the diaphragm and the point, substantially as set forth and shown in Figs. 16, 17, 18, 19, 22, and 26.

Fifth. In a phonograph or phonet, a rubber spring, or similar device, to dampen the vibration of the diaphragm, and prevent false vibrations, as set forth and shown in Figs. 16 and 21.

Sixth. The combination with the diaphragm in a phonograph or phonet apparatus of a lever to modify the relative action of the diaphragm and point, substantially as described, as shown in Figs. 17, 18, 27.

Seventh. The combination with the diaphragm and point of a permanent or electro-magnet, substantially as described and represented in Figs. 24, 25, 26.

Eighth. The method of recording and reproducing two or more sounds or speeches simultaneously, substantially as described, and as illustrated by Figs. 28, 29, and 48.

Ninth. A phonet composed of a perforated sirene and a jet tube, substantially as described, and represented in Fig. 30.

Tenth. The mechanism for producing a phonogram, and employing the same in a phonet, substantially as described, and illustrated in Figs. 32, 33, 35, 36, and 37.

Eleventh. The combination with the phonograph, diaphragm, and point of a sound chamber, substantially as described, and illustrated in Figs. 31, 38, 39, and 53.

Twelfth. The diaphragm and mouth-pieces for a speaking phonograph, substantially as described, and as illustrated in Figs. 41, 42, 43, 44, 45, and 46.

Thirteenth. The combination with a diaphragm and its point of two diaphragms for the purposes, and substantially as shown in Figure 49.

Fourteenth. The combination with a diaphragm and valve actuated by sound vibrations a source of compressed fluid and a trumpet, as in Figs. 51, 52, or a phonograph as in Fig. 50, substantially as set forth.

Fifteenth. The combination of two diaphragms with a valve and a source of compressed fluid, as represented in Fig. 67, for increasing the volume of the voice or other sound, as set forth.

Sixteenth. The combination with two or more phonograms of phonet keys for selecting letters or utterances as described, and illustrated in Fig. 63.

Seventeenth. The means for duplicating or reproducing phonograms from an original phonogram, substantially as set forth.

Eighteenth. The combination with the phonograph or phonet of the revolving crank and pendulum governor, substantially as described and shown in Figs. 64, 65, 66.

Nineteenth. The combination with the phonograph of a lever moved by the lips, and of a lever and phonet to move the lips of a mask, substantially as described, and illustrated by Figs. 55 and 54.

Twentieth. The combination with a phonogram of a clock movement or toy and a phonet for reproducing sounds for clocks or toys, substantially as set forth.

In witness whereof, I, the said Thomas Alva Edison, have hereunto set my hand and seal this 17 day of September, A.D. 1878.

THOMAS ALVA EDISON. (L.S.)

Witnesses,
Chas. H. Smith,
76, Chambers St., New York.
Harrold Serrell, 76, Chambers St., New York.

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A.D. 1878. April 24. N.o 1644.
EDISON'S Specification.
(4th Edition)

Fig. 1.

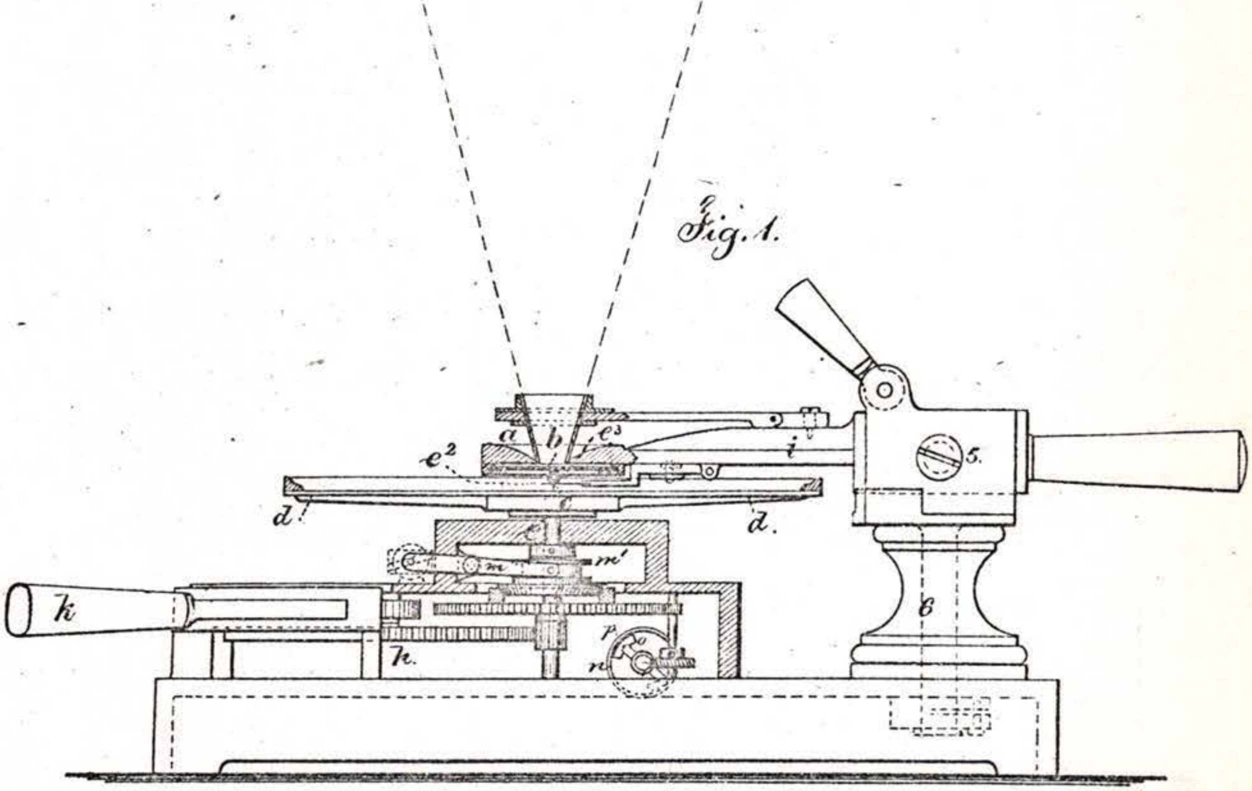
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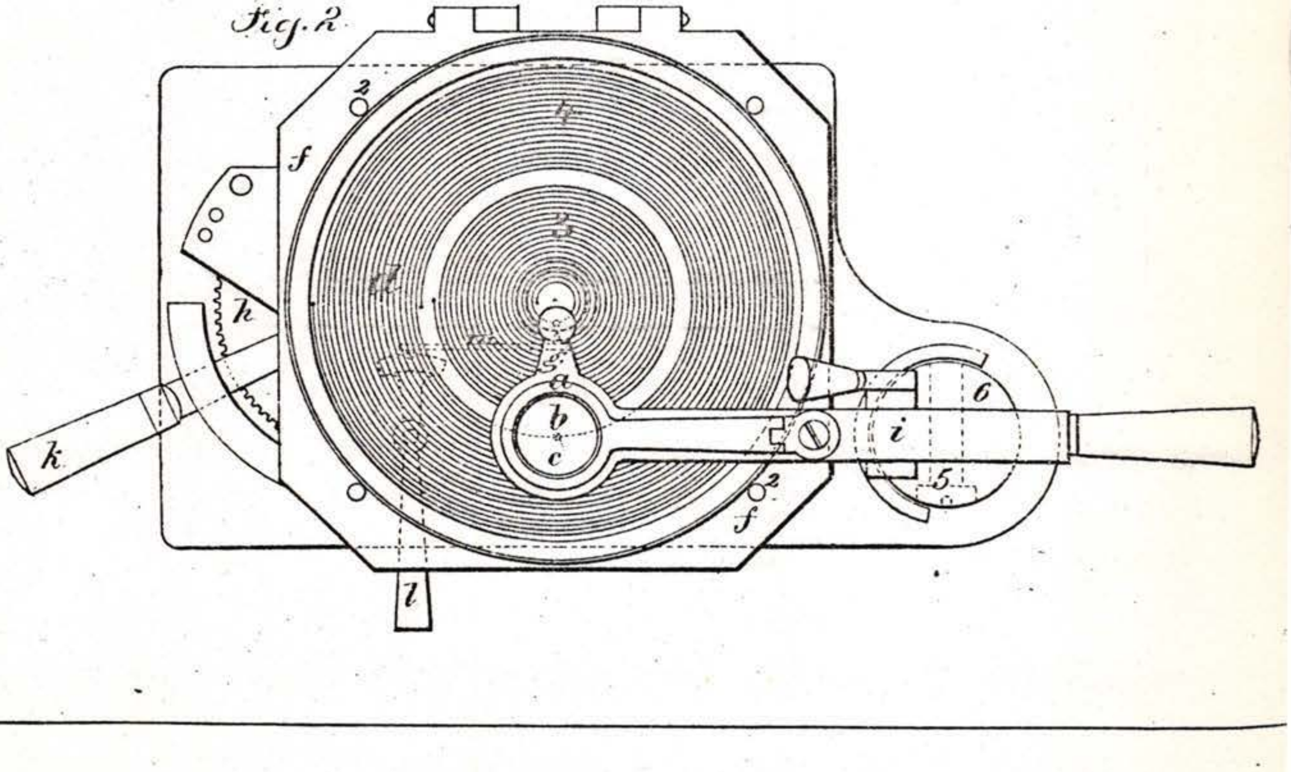
Fig. 2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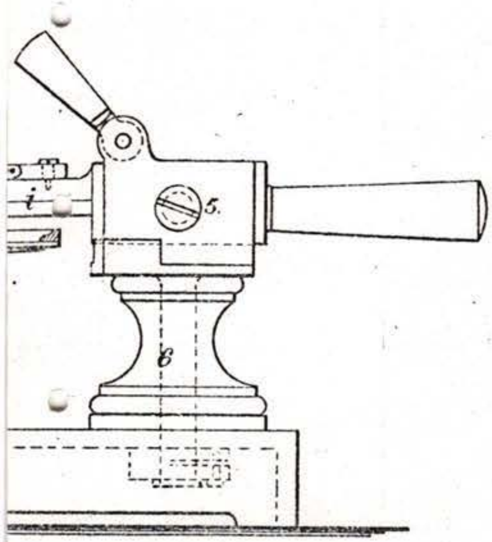
(4 SHEETS)
SHEET 1.

1.



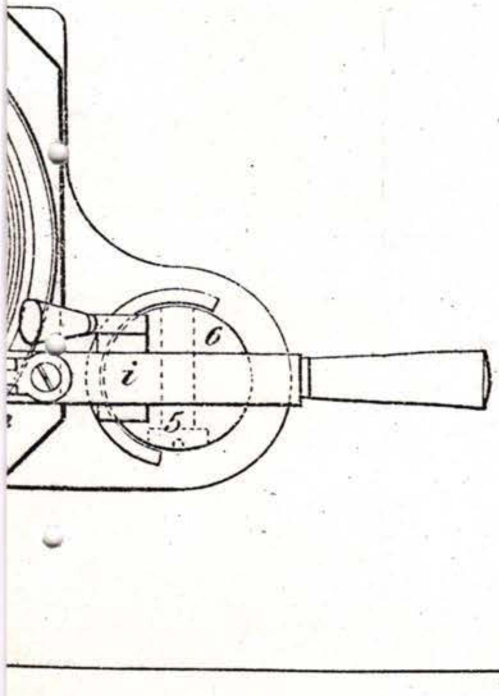
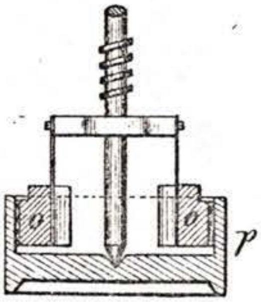


Fig. 4.



Figs. 6.

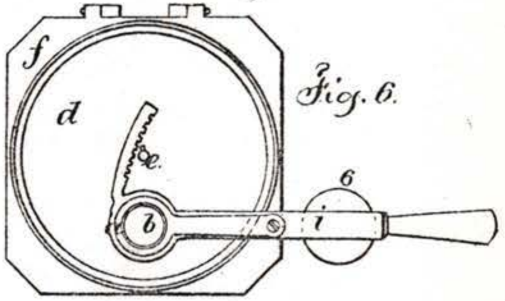


Fig. 3.

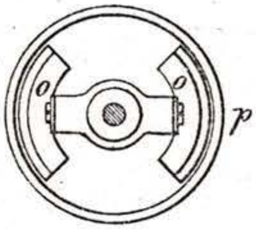


Fig. 7.

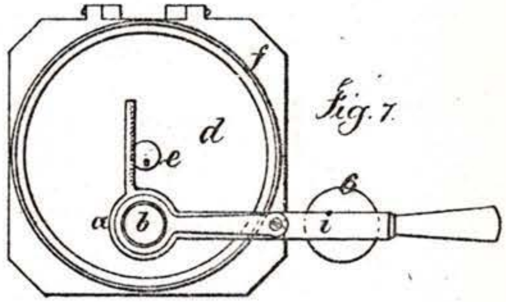


Fig. 5

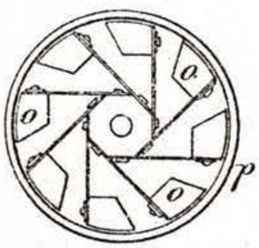


Fig 8.

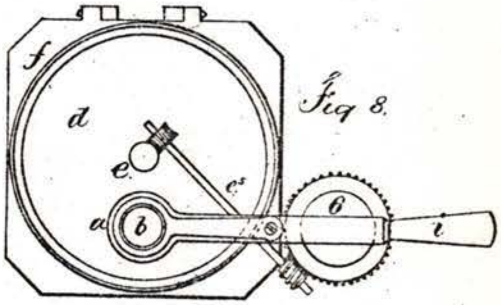
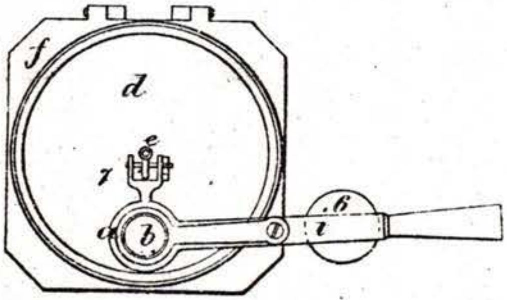


Fig. 10.



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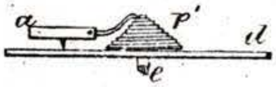

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Fig. 11.

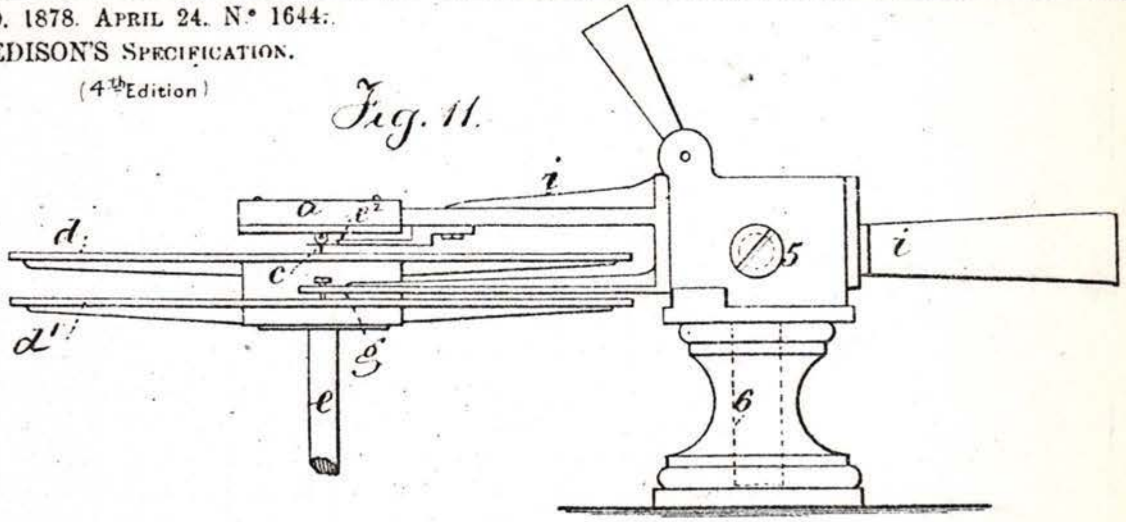

i
a
e²
d
c
5
i
d'
g
e
6

Fig. 12.

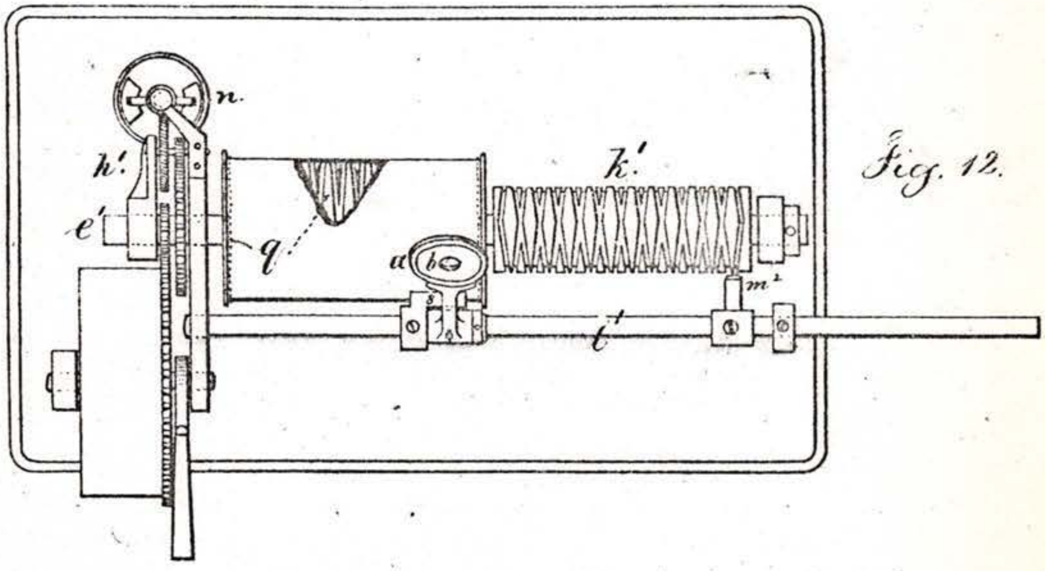
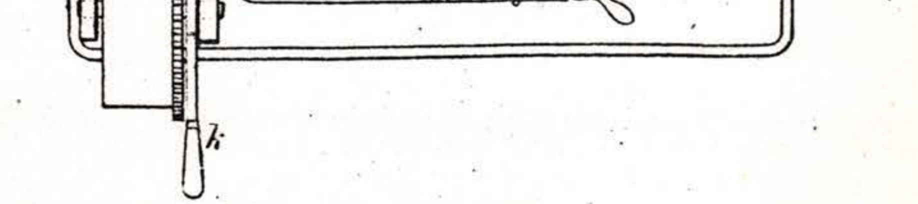

n.
h'
k'
e'
q
a
b
m²
t'

Fig. 13.


n
h'
q
n²
e'
a.
o'
9
k

(4 SHEETS)
SHEET 2.

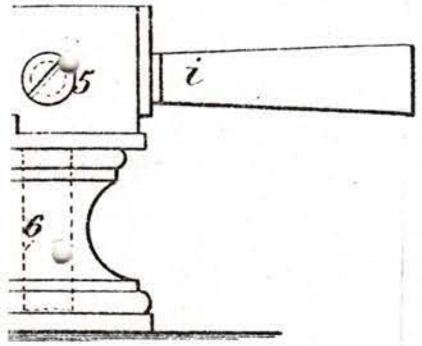
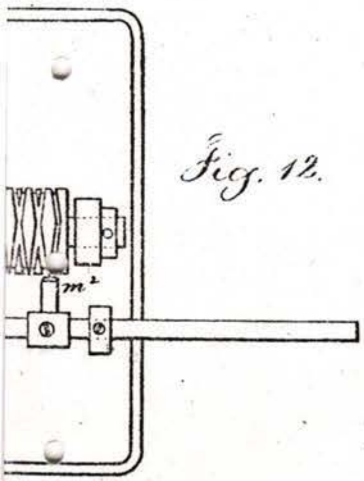


Fig. 12.



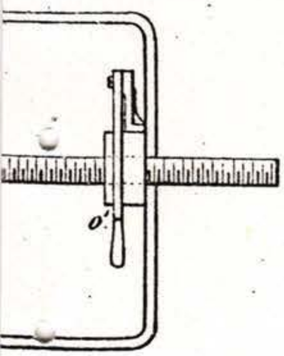


Fig. 14.

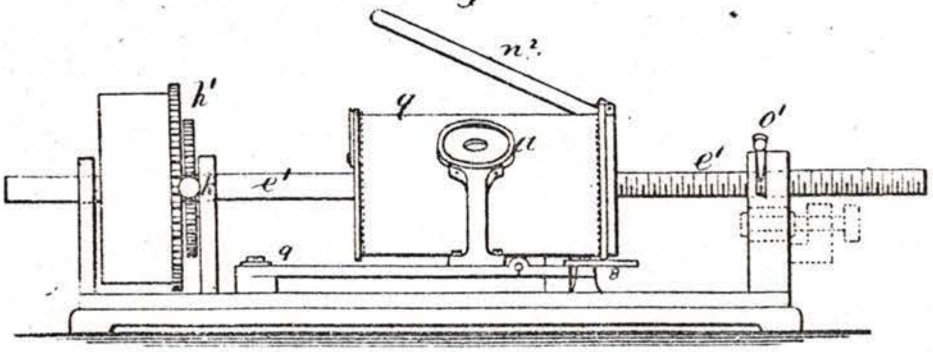

n².
h'
q
a
e'
e'
o'
q
8

Fig. 15

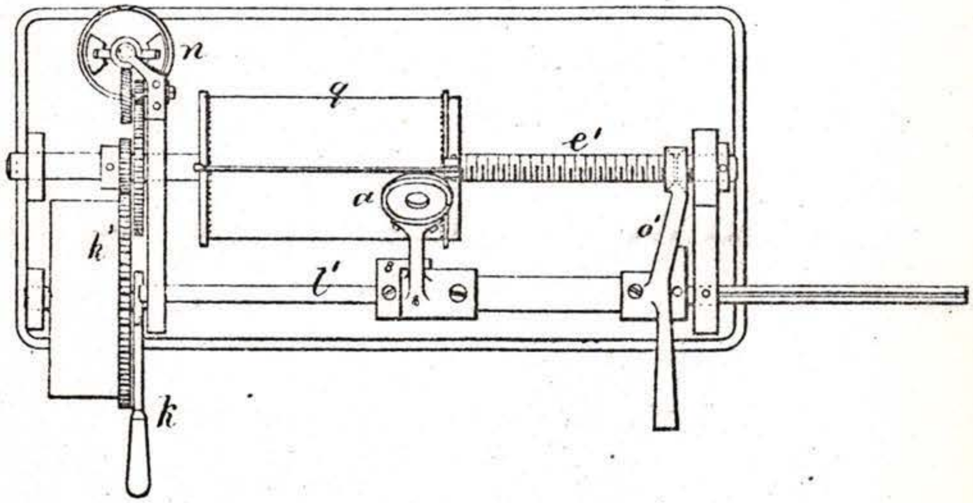


Fig. 16.

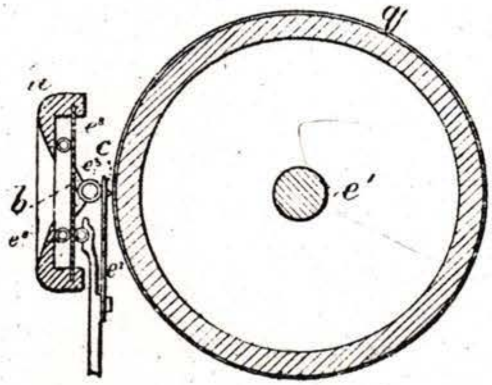

q
a
c
e³
b
e'
e¹
e²

Fig. 17.

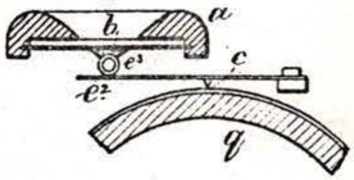


Fig. 18.

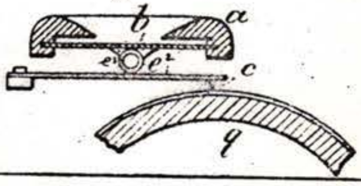


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Fig. 20.

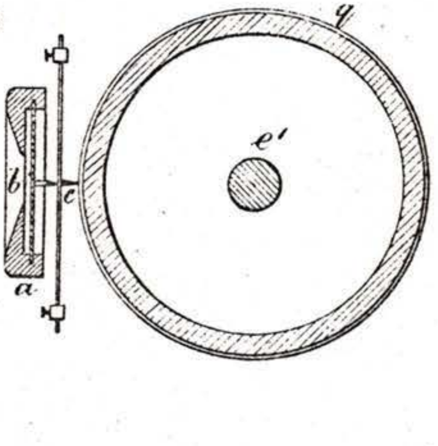


Fig. 19.

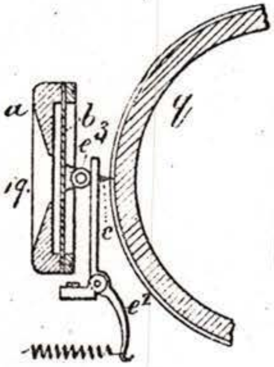


Fig. 21.

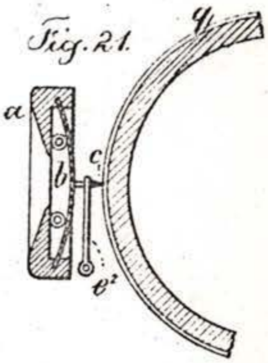


Fig. 22.

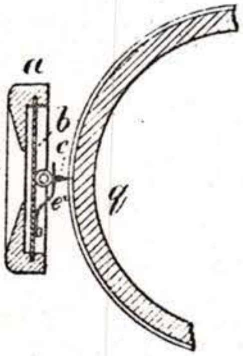


Fig. 23.

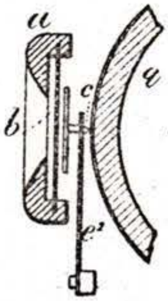


Fig. 24.

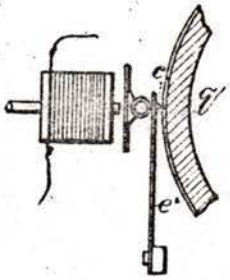


Fig. 25.

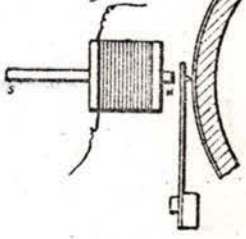
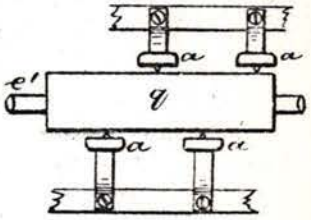


Fig. 28.



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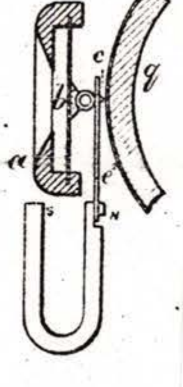


Fig. 27.

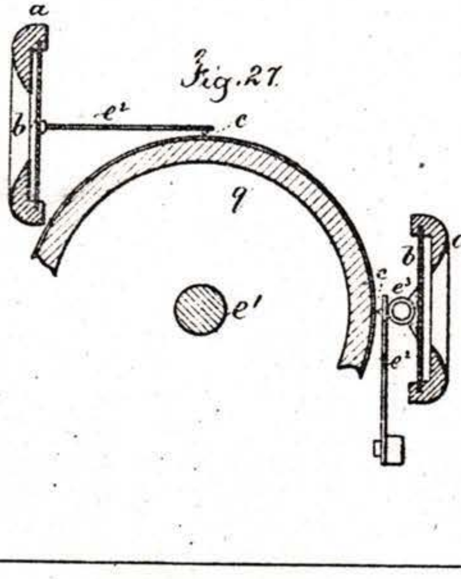
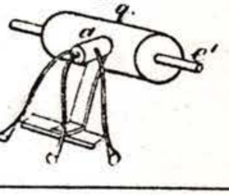

a
b
e2
c
q
e'
b
a
c
e3
e'

Fig. 29.



(4 SHEETS)
SHEET 3.

Fig. 31

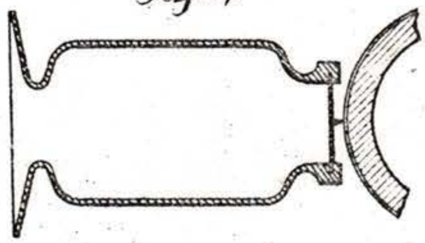


Fig. 30.

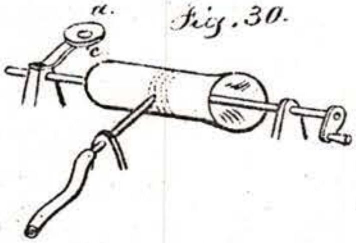


Fig. 21.

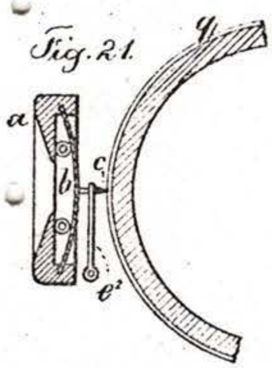


Fig. 34.

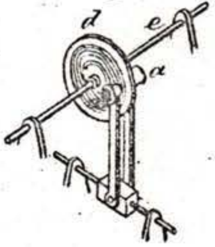


Fig. 35

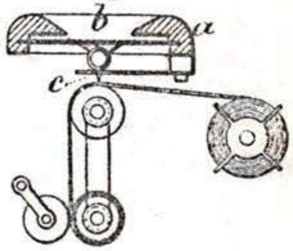


Fig. 33

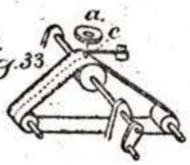


Fig. 32

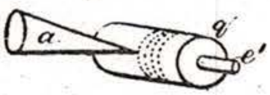


Fig. 25.

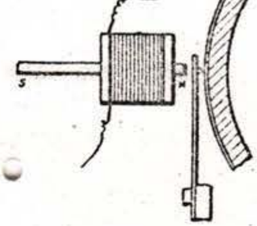


Fig. 36

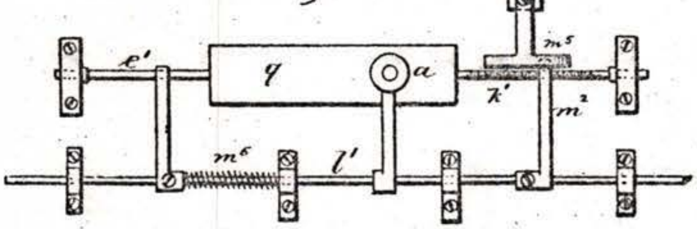

e'
q
a
m⁵
k'
m²
m⁶
l'

Fig. 37

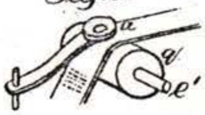


Fig. 43.

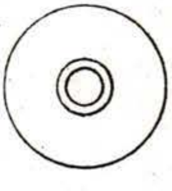


Fig. 28.

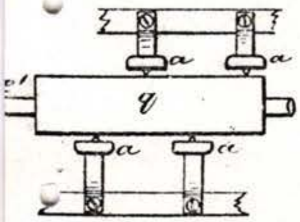


Fig. 38

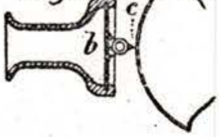


Fig. 39.

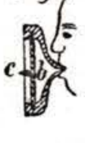


Fig. 40

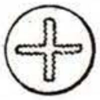


Fig. 41.

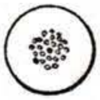


Fig. 42

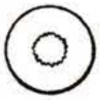
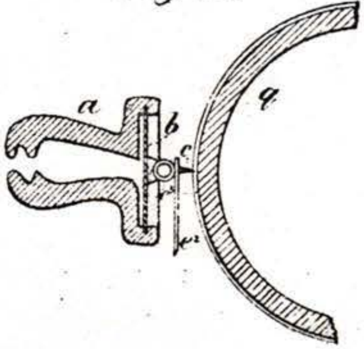


Fig. 46.



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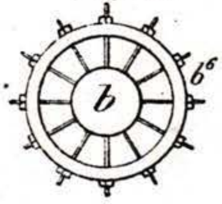

Fig. 44

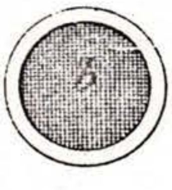

Fig. 24.

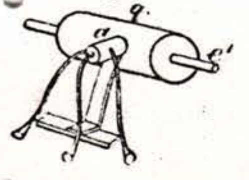

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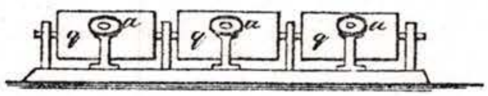
Fig. 48.



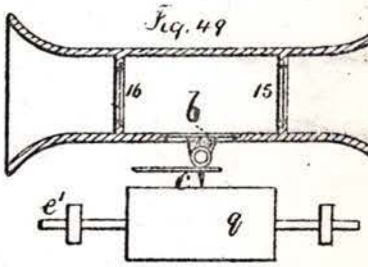


Fig. 49

Fig. 47.

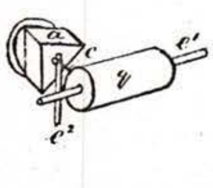


Fig. 50.

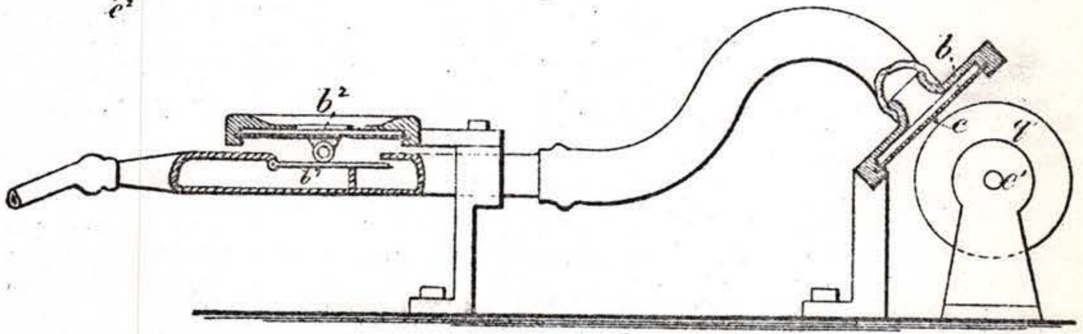


Fig. 51.

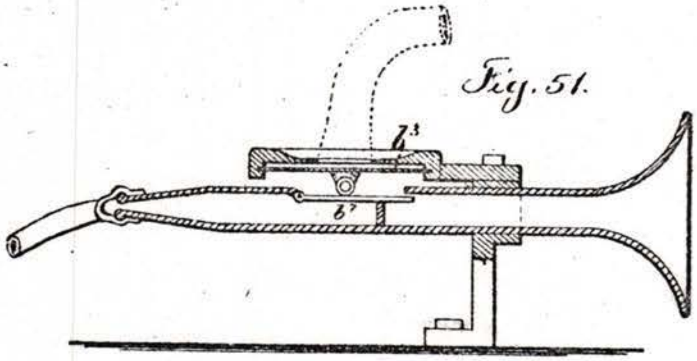


Fig. 53

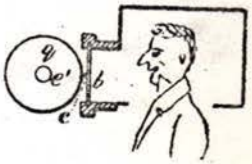


Fig. 54.

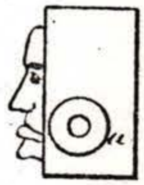
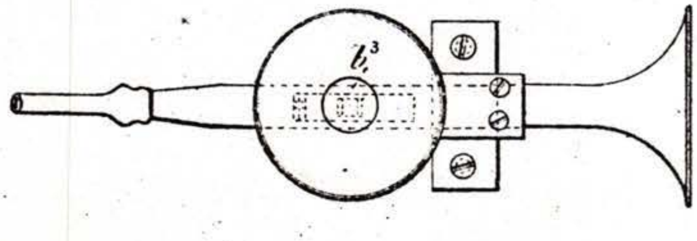


Fig. 52.



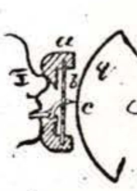


Fig. 55

315
316

(4 SHEETS)
SHEET 4.

Fig. 49

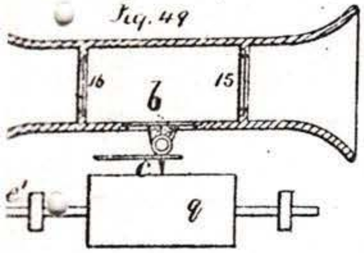


Fig. 56.

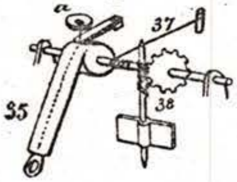


Fig. 57

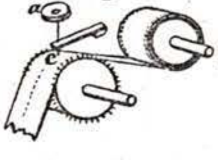


Fig. 58.

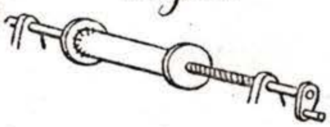
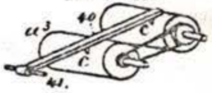


Fig. 59.


a⁴
a³
40
c
c
41

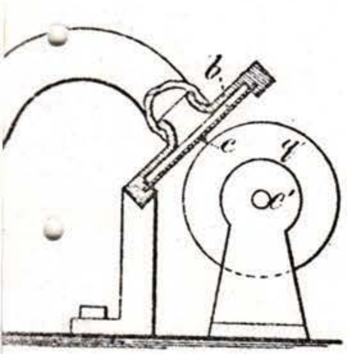


Fig. 60

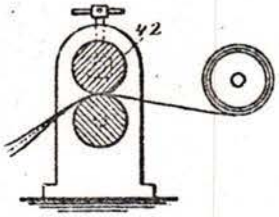


Fig. 61.

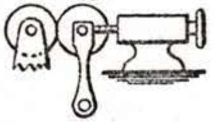


Fig. 62

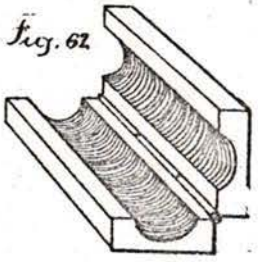


Fig. 63

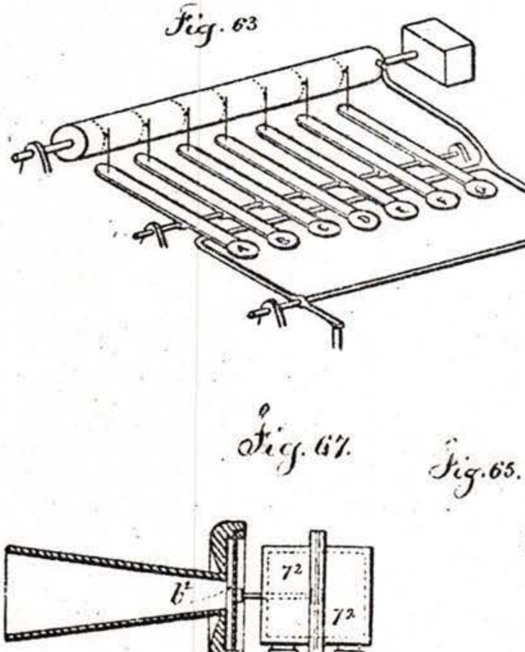


Fig. 64.

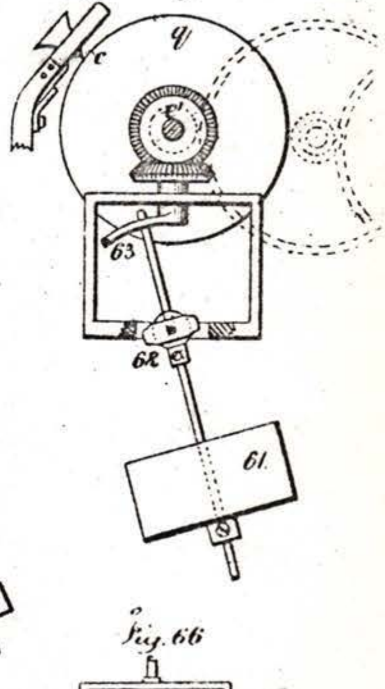


Fig. 53

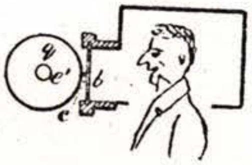


Fig. 54.

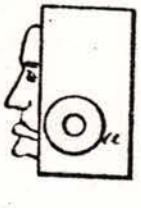


Fig. 67.

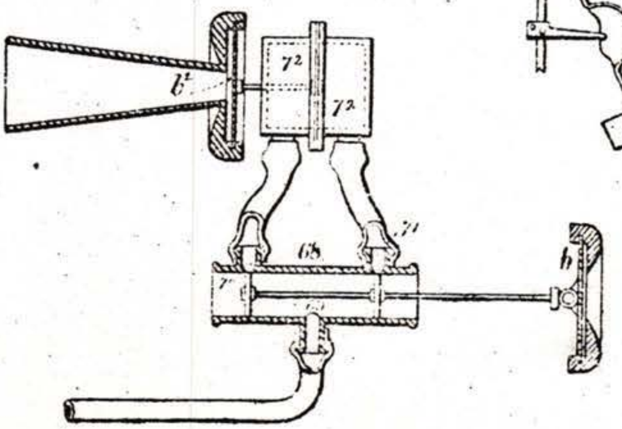

72
72
b'
68
71
7'
h

Fig. 65.

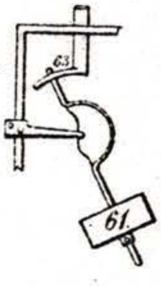
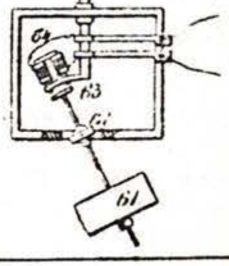


Fig. 66



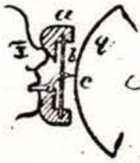


Fig. 55

UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA,

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO. } IN EQUITY ON LETTERS PATENT NO. 658, 615.

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO. } IN EQUITY ON LETTERS PATENT NO. 680, 676.

NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO. } IN EQUITY ON LETTERS PATENT NO. 831, 668.

[Fourth Edition.]

Complainants' Exhibit, British Patent No. 15.232 of 1887 to Berliner.

Nº 15,232 **A.D. 1887**

Date of Application, 8th Nov., 1887—Accepted, 9th Dec., 1887

COMPLETE SPECIFICATION.

Improved Method of and Apparatus for Recording and Reproducing Spoken Words and other Sounds.

EMILE BERLINER of Columbia Road Washington in the District of Columbia United States of America Electrician do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has reference to a novel method of, and apparatus for recording and reproducing all kinds of sounds, including spoken words, and is designed to overcome the defects inherent in that art, as now practised and in the apparatus used therefor.

By the ordinary method of recording spoken words or other sounds for reproduction, it is attempted to cause a stylus attached to a vibratory diaphragm to indent a travelling sheet of tin foil or other like substance to a depth varying in accordance with the amplitudes of the sound waves to be recorded. This attempt is necessarily more or less ineffective for the reason that the force of a diaphragm vibrating under the impact of sound waves is very weak, and that in the act of overcoming the resistance of the tin foil or other material, the vibrations of the diaphragm are not only weakened, but are also modified. Thus, the record, while it contains as many undulations as the sounds which produced it, and in the same order of succession, the character of the recorded undulations is more or less different from those of the sounds uttered against the diaphragm. There is then, a true record of the pitch, but a distorted record of the quality of the sounds obtained.

The simple statement that the material upon which the record is made resists the movement of the diaphragm is not sufficient to explain the distortion of the character of the undulations; for, if that resistance were uniform, or even proportional

[*Price 8d.*]

to the displacement of the stylus, the record would be simply weakened, but not distorted.

But it is a fact, that the resistance of any material to indentation, increases faster than the depth of indentation; so that a vibration of greater amplitude of the stylus meets with a disproportionately greater resistance, than a vibration of smaller amplitude. For this reason, loud sounds are even less accurately recorded than faint sounds, and the individual voice of a loud speaker recorded and then reproduced by the phonograph cannot be recognised.

With a view of overcoming this defect, it has been attempted to engrave instead of indent a record of the vibrations of the diaphragm, by employing a stylus shaped and operating like a chisel upon a suitably prepared surface; but even in this case, the disturbing causes above referred to are still present. In addition to this, if in the apparatus of the phonograph or graphophone type, it is attempted to avoid the disturbing influence of the increase of resistance of the record surface, with the depth of indentation or cut, as much as possible, by primarily adjusting the stylus so as to touch the record surface only lightly, then another disturbing influence is brought into existance by the fact that with such adjustment when the diaphragm moves outwardly, the stylus will leave the record surface entirely, so that part of each vibration will not be recorded at all. This is more particularly the case when loud sounds are recorded, and it manifests itself in the reproduction, which then yields quite unintelligible sounds.

It is the object of my invention to overcomethese and other difficultiesby recording spoken words or other sounds without perceptible friction between the recording surface and the recording stylus,and bymaintaining the unavoidable frictionuniform for all vibrations of the diaphragm. The record thus obtained, almost frictionless, I copy in a solid resisting material, by any of the methods hereinafter described: and I employ such copy of the original record for the reproduction of the recorded sounds.

Instead of moving the recording stylus at right angles to, and against the record surface, I cause the same to move under the influence of sound waves, parallel with and barely in contact with such surface; which latter is covered with a layer of any material that offers a minimum resistance to the action of a stylus operating to displace the same; all substantially in the manner of the well known Phonautograph by Leon Scott.

All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings which illustrates two ofthenumerous forms which my improved apparatus may assume, and in which—

Fig. 1 is a perspective view of one form of my recording and reproducing apparatus.

Fig. 2, is a like view of the recording and reproducing diaphragm with its stylus.

Fig. 3, a similar view of a portion of the support for the record surface.

Fig. 4, the same view with the record surface applied.

Fig. 5, a plan view of a phonautographic record.

Fig. 6, a perspective of a phonautographic record, copied in solid resisting material.

Fig. 7, the copied record mounted, ready for application to the support.

Fig. 8, is a perspective view of another form of my gramophone, in which the sounds are recorded upon a plain surface, as distinguished from a cylindrical surface used in connection with the apparatus shown in Figs. 1 to 7.

Fig. 9, is a plan view of the diaphragm with its support, and a recording and reproducing stylus, detached from the apparatus as a whole.

Fig. 10, is a sectional view of the same.

Fig. 11, is a cross-section on line *x*, *x*, of Figure 9.

Fig. 12, is a vertical section, showing the recording disc and its connection with the driving gear.

Fig. 13, is a sectional view of a part of the driving gear.

Fig. 14, is a section showing the connection of the driven shaft with the support of the recording disc.

Fig. 15. is a sectional view of a centering device employed in this form of apparatus; and Fig. 16 is a plan view, upon a reduced scale, of a disc with a record of sound recorded upon the same, in accordance with my invention.

The general arrangement of the first form of my apparatus is best illustrated in Fig. 1 in which a T shaped base plate A, is shown, upon which two standards H, I, serving as journal bearings for the shaft of drum G, are mounted. The drum G, may be constructed with flanges e, e^1, which project beyond the cylinder surface f, and from the edges of a gap B, left upon the cylinder surface, extend the side walls of box K as shown. A thin layer of felt, or other yielding, elastic substance, is placed upon the cylinder surface, and is bent over the edges of the gap and secured to the side walls of the box K; this layer of elastic material is designed to serve as the support for the record surface both in recording and reproducing.

For recording, I employ a thin strip of paper, parchment, metal or any other suitable substance, which is secured at both ends to bars c, d, in the manner shown in Fig. 7, with reference to a copy of a record; and is then placed upon the elastic support f^1, with the bars c, d, entering into but projecting at both ends beyond the box K, as illustrated in Figs. 1 and 4 with reference to an engraved copy of a record. Bolts q, passing through the projecting ends of bars c, d, are employed to draw the record strip tightly about the drum, and the length of the strip is such, that the ends of the same meet as nearly as practicable upon a straight line z. The record sheet is then prepared to receive the record, by covering its surface with a thin layer of any substance which is easily removed by the action of the recording stylus. I may use lamp-black, which is deposited by placing a smoky flame under the record strip, and by slowly turning the drum until all parts of the strip are covered with the deposit. It is well known that a layer of lampblack thus deposited while it adheres well to the surface of a solid body, is nevertheless, easily removed from the same; it requires only an exceedingly small force to draw a plainly visible line upon such surface owing to the fact that the spicules of carbon, of which lampblack is composed, are only loosely superimposed upon each other, and are exceedingly light. All this has long since been recognised and utilized in the production of phonautographic records, and I take advantage of these facts in my improved method of recording and reproducing sounds.

The diaphragm m, is mounted in a frame n, with its plane at right angles to the axis of drum G. A post O, is fixed to the centre of the diaphragm, and a slot in said post receives one end of stylus S, which is pivoted in the post by a pin t. The stylus extends over and beyond the frame, with its free end barely in contact with the record surface, and is also pivotally supported in a slot in a post p, secured to the frame by means of a pin u, as shown in Figs. 1 and 2.

It will now be seen, that the stylus is in effect, a lever having its fulcrum in the pin u, and that its free end can only move in lines practically parallel to the record surface. If it is now desired to produce a record of sounds, the drum is slowly and uniformly rotated by means of crank L, or by any other suitable means, and sounds are uttered or directed against the diaphragm. Under the impact of the sound waves, the diaphragm is set into vibrations, whereby the free end of the stylus is also caused to vibrate to the right and left of its normal position, removing at the same time an undulating line y, of lamp-black from the record surface, as indicated, greatly exaggerated in Fig. 5. Since, in this operation, the stylus only penetrates a uniform layer of loosely heaped carbon spicules, and barely touches the record surface, it is clear that the slight friction at the free end of the stylus will be uniform, whatever be the amplitude of vibration. Consequently the vibrations of the diaphragm will not be modified or changed by the reaction upon the same of a sensible and varying resistance, as is the case in all other mechanical sound recorders.

Having thus obtained an accurate phonautographic record, the same may be fixed, by applying a thin solution of varnish of any kind, which dries very rapidly, and which does not obliterate or change the record.

If in this process the deposit of lamp black be made thick enough, the line drawn by the stylus would represent a groove of even depth, preserving all the characteristics of the sounds which produced it, and which may be handled and touched with impunity. The latter is then removed from the drum, and may be preserved any length of time without danger of its being disfigured. This record I then copy in solid resisting material, preferably metal, either by the purely mechanical process of engraving, or by chemical deposition, or by photo-engraving. I prefer the last named process, which enables me to produce the most accurate copy of the original record, in copper, nickel or any other metal, without in any way or manner affecting the original record. The copy thus obtained, which may be multiplied to any desired extent, is a grooved wave line upon a strip or sheet of copper, or other metal, as shown in Figs. 1, 4, 6 and 7, and for the reproduction of the recorded sounds, it has the advantage over the ordinary records in tin foil, wax, etc., that it is not sensibly attacked by the reproducing stylus, and will stand an indefinite number of reproductions without the slightest variation in the accuracy and loudness of the reproduced sounds. The copied record is fixed at both ends to the bars c, d, as shown in Fig. 7, and is placed upon the elastic support f^1, upon the drum, in the same manner as has been described with reference to the original record strip, and as is illustrated in Figs. 1 and 4. Care must be taken, that the two ends of the undulatory groove y, meet exactly, as will be readily understood.

This condition of the apparatus is shown in Fig. 1 with the engraven record upon the drum, and the free end of the stylus entering the undulatory groove.

If now the drum is rotated with uniform speed, the end of the stylus will be forced to follow the undulations of the groove y, and the diaphragm will be vibrated positively in both directions in strict accordance therewith, and will therefore, reproduce the exact sounds which originally produced the record. This peculiarity of positive vibratory movement in both directions of the diaphragm, is a feature which also distinguishes my method and my apparatus, from others heretofore used.

In the phonograph and graphophone, the end of the reproducing stylus which bears upon the indented or engraved record, has a vertical upward and downward movement; it is forced upwardly in a positive manner by riding over the elevated portion of the record, but its downward movement is effected solely by the elastic force of the diaphragm, which latter is always under tension. In my improved apparatus, the stylus travels in a groove of even depth and is moved positively in both directions; it does not depend upon the elasticity of the diaphragm for its movement in one direction. This I consider to be an advantage, since by this method the whole movement of the diaphragm is positively controlled by the record, and is not affected or modified by the physical conditions of the diaphragm which conditions necessarily vary from time to time, and constitute some of the causes of imperfect reproduction of recorded sounds.

In practising my method of recording and reproducing sounds, I am not limited to the use of the identical apparatus herein shown and described; this apparatus may be varied indefinitely without seriously impairing its utility for the purposes in view.

Thus, it is not absolutely necessary that a diaphragm should be used for receiving the impact of sound waves in recording and for remitting sounds in reproducing; any sonorous body, of whatever shape and material, may be used in lieu of a diaphragm proper. The recording surface need not be mounted upon a drum, but may be supported in any suitable manner upon a support of any description which is adapted to move the same under the stylus evenly and with approximately uniform speed.

Nor do I confine myself to the use of lamp-black as a substratum for the phonautographic record, although I have found this substance to yield excellent results; any other substance which adheres well to the support, and may at the same time be removed from the same with a minimum force, may be employed.

Thus far I have described a method of recording and reproducing sounds which consists in first causing the sounds to inscribe themselves upon a layer of non-resisting material in a manner substantially like that practised by the well known

Leon Scott Phonautograph; then copying the phonautographic record in solid resisting material, preferably by the photo-engraving process, and then reproducing the sounds from the solid copy of the record.

The original record as well as the copy of the same, is obtained as has been seen, as an undulatory line of even depth, as distinguished from a line of varying depth obtained by the ordinary Phonograph and by the Graphophone.

In the second form of my invention, I retain all the fundamental features of my gramophone, but introduce certain novel features both in the process and in the apparatus, which render the attainment of the objects of a sound recorder and reproducer still more certain and more perfect.

In the original form of my gramophone above described, I employ a curved (cylindrical) surface upon which the non-resisting medium used for recording is supported; this has the disadvantage that, for the purpose of copying the record by the photo-engraving process, such surface has to be first straightened, and the flat copy obtained from the same has to be bent again to the original cylindrical form of the record surface. This involves delicate and tedious manipulations, which I avoid in my second form of apparatus, by inscribing the record of sounds upon a flat plate, and I further improve the process by arranging that flat plate horizontally, and by inscribing the record upon the under surface of the same, whereby the material removed by the recording stylus drops away from the plate, and leaves the undulatory groove of even depth clean and well defined; whereas by the method as practised with the apparatus above described, the material removed by the stylus accumulates in and about the adjacent grooves.

I further improve the process, by using a transparent plate as a support for the non-resisting medium; this plate is therefore made either of glass or some other like substance, whereby I secure several important advantages. The most important of these advantages is, that it enables me to work with parallel transmitted rays of light in the subsequent process of photo-engraving, in which the original record is thus used as a negative; and another important advantage is, the reduction of the friction of the stylus upon the support, to a minimum.

The process is further improved by the employment of a new recording medium. In the original process I use a layer of lamp-black, pure and simple, and this substance is well adapted for the purpose, on account of the slight coherence of the particles; but by reason of the flocculent nature of this substance, the lines drawn upon it are more or less ragged, as can be observed under the microscope, and the photo-engraving obtained from such record displays all the defects of the original. In my improved second process, I employ a layer of a semi-fluid ink or paint, of such consistency and thickness that it will neither subside nor flow spontaneously. Such ink is practically structureless, and the lines drawn upon it are exceedingly sharp and reveal no ragged edges under a powerful microscope, and the photo-engraving from such record is far superior to a like copy from a record produced under the former process.

Referring now to Figs. 8 to 16, in which the details are marked by numerals, there is a platform 1, suitably supported, and upon this platform are mounted the operative parts of the apparatus. A metallic plate 2, provided with a longitudinal rib 3, is secured upon the platform, and standards 4, 4^1, mounted upon plate 2, are provided with a nut bearing 5, and a smooth bearing 5^1, respectively, for the shaft 6, which extends through these bearings as shown. One half, more or less of this shaft, is screw threaded as shown, and enters the nut bearing 5, and at a point near the middle said shaft passes loosely through a movable support 7, the position of which upon the shaft is determined by two collars 8, 8, as indicated in Fig. 14. The support 7, serves as a bearing for a bevel gear 9, which is centrally perforated and widens out into a circular flange 10. Upon its underside, the bevel gear 9, is recessed, and said recess fits loosely over the upper end of support 7; a screw 11 Fig. 12 passing loosely through the central perforation of bevel gear 9, screws into the head of support 7, so that the bevel gear can rotate about its axis, which coincides with the axis of screw 11. Two screw pins 12, 12, which may be either fixed or removable, project at diametrically opposite points, from flange 10, and are designed to pass through two similarly located holes in a glass plate 13, as will be more fully described hereinafter. A bevel gear 14, fixed upon shaft 6, engages bevel gear 9, but provision is made for releasing gear 14, from the shaft if desired, for a purpose which will be explained further on. As stated above, the screw threaded portion of shaft 6, passes through nut-bearing 5, and it will now be clear, that if shaft 6 is rotated, bevel gear 9, with its flange 10, will likewise rotate, and will at the same time advance in a straight line; since shaft 6, screwing into or out of its nut-bearing 5, will carry bevel gear 14, and support 7, with it. From the bottom of support 7, two lugs 15, 15,—one on each side of rib 3, of plate 2,—serve to guide the support with the parts attached thereto, in the line of said rib, which is of course parallel to shaft 6. A part of the smooth portion of shaft 6, has a longitudinal groove 16, extending to the right hand end of the shaft (as seen in Figs. 8 and 13), and a sleeve 17, loosely fitting this portion of the shaft, has a pin 18, the end of which engages groove 16, as shown in Fig. 13, so that the shaft is free to slide longitudinally through sleeve 17, and will rotate with the same if the latter is rotated.

Sleeve 17, is fitted into bearing 5^1, of standard 4^1, so as to rotate within the same, and upon that part of the sleeve which projects beyond the bearing, is keyed the compound gear 19. The latter is composed of a pinion 20, and a bevel gear 21; and a rather large bevel wheel 22, mounted upon a shaft 23, below platform 1, meshes with pinion 20.

A small bevel gear 24, meshes with gear wheel 21, and to the shaft of gear 24, are secured fans 25, which are thus driven at a high speed and serve as a regulator, as will be readily understood by those skilled in the art.

A weight 26, is suspended by cords or chains 27, from shaft 23, and if said shaft is turned by a crank 28, or otherwise, in one direction, the cords or chains are wound upon the same, as indicated in Fig. 8, and the weight 26, is raised up toward the platform. If on the other hand, the weight is allowed to descend, it will rotate shaft 23, this in turn will rotate gear wheel 22, which meshing with pinion 20, will rotate the latter and the connected shaft 6, and in the manner hereinbefore described, the support 7, will receive a rectilinear motion, while flange 10, upon bevel gear 9, will both rotate and move in a straight line. For every complete revolution of bevel gear 14, support 7, and bevel gear 9, with its connected flange 10, will be moved in the line of a diameter, a distance equal to the pitch of the screw threads upon shaft 6: and it will now be understood, that if a plate 13, is fixed to flange 10, and a fixed pencil or stylus be lightly pressed upon the plane surface of said plate, a spiral line will be drawn upon the plate. The recording stylus 29, is mounted upon a diaphragm 30, substantially in the manner shown in and described with reference to Figs. 1 and 2. The diaphragm itself, which may be of any suitable sonorous material, is mounted in a case 31, Fig. 10, a rigid tube 32, projecting from one side of the case communicating with a flexible tube 33, and with a mouth or ear-piece 34. The tube is clamped and may be adjusted in the direction of its length in a ring 35, formed at the end of a rod 36, which is adjustable in a support 37; and the latter is again adjustable vertically in a standard 38, mounted upon platform 1. A metal post 39, is fixed to the centre of the diaphragm, as shown, and its free end has an axial slot 40, into which a soft rubber tube 41, is forced and flattened. The free end of the soft rubber tube receives the stylus 29, which may be of metal or any other hard and fairly elastic material.

Preferably, the stylus is made of a flat strip of phosphor bronze, extending radially over the face of casing 31, and some distance beyond the edge of the same. At its free end, the stylus is reduced to a point, and is curved upwardly, and by turning the diaphragm case about the axis of tube 32, or by turning rod 36, in its bearing 37, or by adjusting the latter upon bracket 38, the point of the stylus may be brought into light contact with the lower face of disc 13, at a point in diameter of said disc which is parallel with shaft 6. Near the middle of its length, a hole is produced through the stylus, and a pin 42, formed at one end of a metal block 43, passes through said hole, and into the central bore in a similar block 44. Between each block, and the adjacent face of the stylus, a soft rubber washer 45, is inserted, and the two blocks are forced together and are made to clamp the stylus between the rubber washers, by means of the pointed screws 46, working in the supports 47. The screws 46, 46, thus constitute the pivotal supports of the stylus, which is a true two-armed lever; a piece of soft rubber tubing 48, is inserted between the outer arm of this lever and the casing 31, and another piece of soft rubber tubing 49, is slipped over the stylus between the elastic support 48, and the outer end. Thus it will be seen that the stylus is elastically supported and amply dampened, and that if the diaphragm vibrates under the impact of sound waves, the free end of the stylus will move to the right and to the left of its position of rest, and parallel to the face of disc 13. The disc 13, is preferably made of glass, it is of suitable diameter and thickness, and has two holes 12^1, 12^1, Fig. 12, corresponding to the pins 12, 12, projecting from flange 10, and is placed in position upon said flange, with the pins entering the holes; the nuts 50, 50, are then screwed down, whereby the glass disc is securely clamped.

The method of recording and reproducing recorded sounds by means of this apparatus will now be easily understood. As has been stated above, the non-resisting material upon which the sound record or phonautogram is produced, is a semi-fluid, and I can use for this purpose any ink, as for instance printer's ink, of the required consistency; an even layer of this ink may be spread over the under surface of the glass disc, in any suitable manner, as for instance by means of a brush or roller, while the disc is slowly turned. But I prefer to produce the ink directly upon the disc itself, and I proceed in the following manner.

The under surface of the glass disc is first carefully polished and dried, and is then covered with a thin film of oil by means of a camel-hair brush; this is done while the disc is rotated with moderate speed. Any oil or fat may be used, but I have found linseed oil specially adapted for the purpose. A smoky flame is then held under the glass plate while the latter is slowly rotated, whereby the lamp-black ascending from the flame is intercepted by the plate and becomes deposited upon the same in a very fine layer, which, however, is instantly absorbed by and mixes intimately with the thin layer of oil, thus forming a black amorphous ink covering the under surface of the glass disc in an even, exceedingly thin layer.

The coating of ink, thus directly formed upon the disc has just the consistency and the thickness required; it will not flow spontaneously, and while it adheres well to the glass plate it requires only a minimum force to remove it from the same, and the point of the stylus in its passage through the substance of the ink experiences no perceptible resistance.

The disc is now ready to receive the phonautogram, and it is moved to the position shown in Fig. 8, with the point of the stylus near the outer edge; the point of the stylus is then adjusted into light contact with the disc, so that the coat of ink is barely penetrated by the same, and the weight 26, is allowed to descend, and to rotate shaft 6, in the manner hereinbefore described. If now, the stylus remained immovable, it would describe upon the under surface of the disc a smooth spiral, the convolutions of which continuously decrease toward the center of the disc; the pitch of the spiral is determined by the pitch of the screw upon shaft 6, and by the relative angular velocities of said shaft and of bevel gear 9, and may in practice be made as small as $^1/_{50}$ of an inch.

If now, during the progress of the disc, sound waves are directed against the diaphragm, through the mouth piece 34, and tubes 33, and 32, the stylus will vibrate to the right and left of the spiral line, inscribing upon the disc an undulatory line of even depth, which line will truly and accurately represent the sounds uttered against the diaphragm. The stylus removes a very sharp line of ink from the disc, leaving the latter quite transparent at this line, while it is quite opaque and will not transmit light at the places not touched by the stylus; the ink removed by the stylus drops away from the disc, as stated above, and does not accumulate in and about the grooves.

An approximate idea of the phonautogram thus produced can be obtained by inspection of Fig. 16, which represents an undulatory spiral line upon a disc with the pitch of the spiral greatly exaggerated. In the drawing, the undulatory line appears black upon a white ground, while in fact the line is transparent upon a black ground.

The phonautogram mayextend to within a short distance from the edge of flange 10, and in practice the cords or chains 27, 27, are made just long enough to drive the disk up to that limit, or the apparatus is mounted at the proper height above the ground, so that the weight will be arrested before the limit of progress of the disc is reached. Bevel gear 14, is then disengaged from bevel gear 9, by unclamping the same from shaft 6, and sliding it upon the same a short distance to the left hand (in the view shown in Fig. 8) and the disc is then given a single rotation by hand, whereby the stylus describes a true circle 51, Fig. 16 upon the disc. This circle, which I call the centering circle, is afterwards utilized, as will presently appear.

The glass disc, with the sound record and centering circle upon the same, is now removed, and the record may be fixed by applying a thin coat of varnish; it may then be handled with impunity.

From this record I produce a copy in copper or any other metal, by the process of photo-engraving and in this process I use the original record as a negative, which enables me to work by transmitted light, and with parallel rays; the copy thus produced will have the exact size of the original, as is well understood by those skilled in the art.

In the photo-engraved copy, the sound record appears as an undulatory line of even depth upon a solid metal disc, and the centering circle 51 is reproduced in the same manner.

For reproducing the original sounds,the centre of the centering circle is determined by well known simple geometrical constructions, and a small hole is drilled through that centre, which hole corresponds to the mathematical axis about which the glass disc had been rotated, and also marks the axis about which the metal disc must be rotated by the apparatus shown,in order that the pointed stylus applied to the starting point of the record may follow the same from beginning to end.

Two holes corresponding to the holes 12^1, 12^1, in the glass disc, are also made in the metal disc,but these holes are preferably made large enough to permit the disc to be adjusted in either direction when placed upon flange 10. Before this is done, a well fitting cylindrical block52,is placed into that part of the cylindrical hole through the common centre of flange 10, and bevel gear 9, which is occupied by the head of screw 11, as shown in Fig. 15; this block which I call the centering block, has a fine axial hole 53 which corresponds exactly to the mathematical axis of rotation of bevel gear 9.

If now the photo-engraved copy of the record is placed upon flange 10, with pins 12, 12, passing through corresponding holes in the metal plate—a fine pin, say a sewing needle, is passed through the centering holes in the disc and in block 52, and the clamp nuts 50 are tightly screwed down. By this simple process, the metallic copy of the original record is safely and quickly centered in position; the stylus is then adjusted with its point in engagement with the outer end of the record groove, and the weight 26 is allowed to descend.

It will now be clear that the stylus wil be forced positively to follow the undulations of the record, and that the diaphragm vibrating under the stylus will emit the same sounds which produced the original record; which sounds can be distinctly heard at the ear-piece 34.

In place of the metallic copy of the original record,I can use a copy made of sealing wax, which is produced by pressing a metal plate, having the record in raised lines, upon a cake or plate of sealing wax which is first softened by heat. The metallic record may thus be preserved indefinitely without being used directly for the reproduction of the recorded sounds, but, simply as a stamp for multiplying the record quickly and cheaply for immediate use.

While I have found the process of photo-engraving to yield admirable copies of the

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phonautographic record, I do not mean to limit myself to this process to the exclusion of other processes for copying and multiplying the original record in solid resisting material; and it will be readily understood that the details of construction of my apparatus and the manipulation of the same may be greatly varied without departing from the fundamental idea of my invention.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. The method or process of recording and reproducing spoken words and other sounds, which consists in first drawing an undulatory line of even depth in a travelling layer of non-resisting material, by and in accordance with sound vibrations; then producing the record thus obtained, in solid, resisting material, and finally imparting vibrations to a sonorous body, by and in accordance with the resisting record, substantially as described.

2. The method or process of reproducing sounds recorded phonoautographically, which consists in copying the phonautographic record in solid resisting material, and then imparting vibrations to a sonorous body, by and in accordance with the copy of the original record, substantially as described.

3. The method or process of reproducing sounds recorded phonautographically, which consists in copying the phonautographic record in solid resisting material by the process of photo-engraving and then imparting positive to-and-fro movements to a sonorous body, by and in accordance with a copy of the original record, substantially as described.

4. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth of a deposit of ink from a travelling plate of glass, by and in accordance with sound vibrations, substantially as described.

5. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth, of a deposit of amorphous, opaque material, from a travelling support of glass by and in accordance with sound vibrations, substantially as described.

6. The method of producing a transparent phonautogram, which consists in removing an undulatory line of even depth, extending along a volute described about a given point, of a deposit of amorphous and opaque material from a rotating disc of glass, by and in accordance with sound vibrations, substantially as described.

7. The method of producing a layer of semi-fluid ink upon a phonautographic support, which consists in first applying a coat of oil or other fat upon the support, and then depositing upon the oiled surface a thin layer of lampblack, substantially as described.

8. As a step in the method of photo-engraving a transparent record of sounds the process of photographing the same, which consists in applying such record directly upon a plate sensitive to light, and exposing the same to actinic action, substantially as described.

9. In a gramophone, the combination of a sound receiving diaphragm or other sonorous body; with a pivoted stylus controlled by a diaphragm, and controlling the same, and a support adapted to carry a phonautographic record sheet or a copy of such record, in solid resisting material, travelling in the plane of vibration of the point of the stylus, substantially as described.

10. In an apparatus for mechanically recording and reproducing recorded sounds, the combination of a sonorous body and a recording and reproducing stylus, mutually controlling each other, with a support for recording and reproducing strips, travelling in the plane of vibration of the end of the stylus, substantially as described.

11. In a gramophone, the combination of a travelling phonautographic record, consisting of a strip or sheet of solid resisting material, having upon its surface undulatory grooves of even depth, similar in form to the undulations of sound waves; with a stylus engaging the grooves of the record, and a diaphragm or other sonorous body controlled by the stylus, substantially as described.

12. In a gramophone, the combination of a sonorous diaphragm and a pivoted stylus;

with an elastic connection between the diaphragmandstylus,and an elastic reactionary dampening support for the free arm of the stylus, substantially as described.

13. In a gramophone, the combination of a diaghragm and pivoted stylus; with an elastic connection between the diaghragm and the stylus, substantially as described.

14. In a gramophone, the combination of a horizontal travelling support for the record surface; with a vibratory diaphragm and a recording stylus bearing upon the under surface of the record surface, substantially as described.

15. As an article of manufacture, a phonautographic record of spoken words or other sounds, which consists of a flexible strip or sheet of solid resisting material, having upon its surface a groove of even depth, undulating to represent sound vibrations, substantially as described.

Dated this 8th day of November 1887.

PHILIP M. JUSTICE,
55 and 56, Chancery Lane, London,
Applicant's Agent.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[G. 9190—125—4/1906.]

A.D. 1887. Nov. 8. N° 15,232.
BERLINER'S COMPLETE SPECIFICATION.

(4th Edition)

SHEET 1.

[This Drawing is a reproduction of the Original on a reduced scale.]

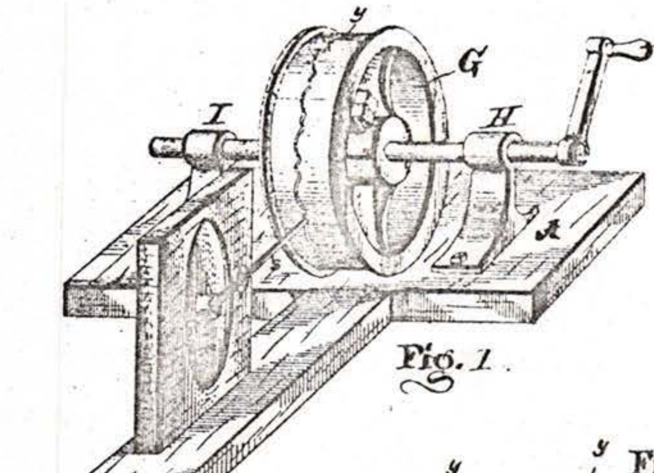


Fig. 1.

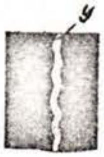


Fig. 5.

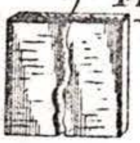


Fig. 6.

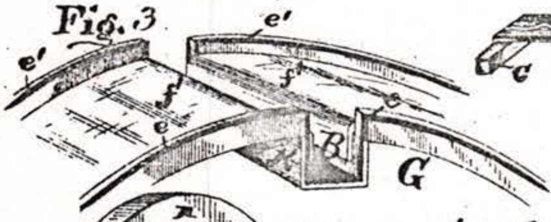


Fig. 3.

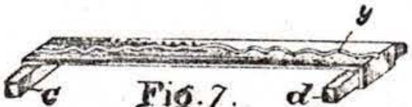


Fig. 7.

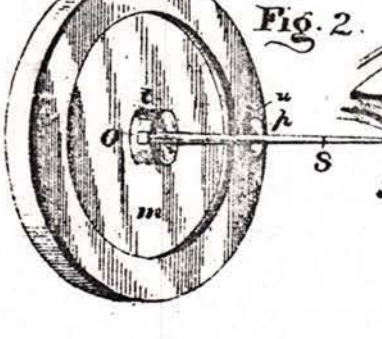
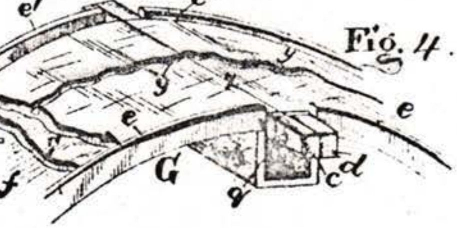


Fig. 2.


e'
e'
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y
z
e
e
f
G
q
c
d

Fig. 4.

3 SHEETS

SHEET 1.

Fig. 6.

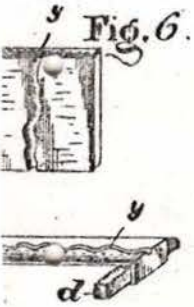

Fig. 4.

SHEET 2

Fig. 8.

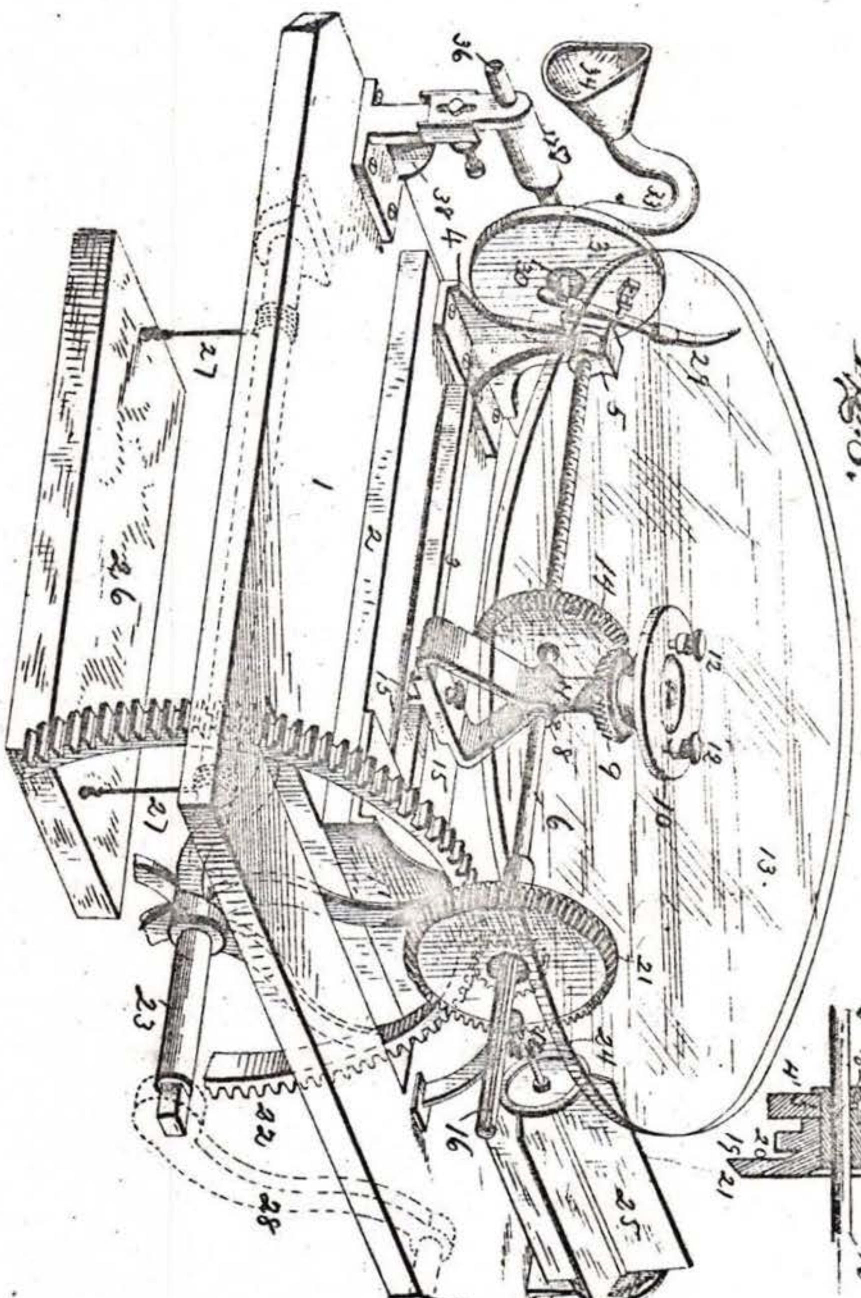
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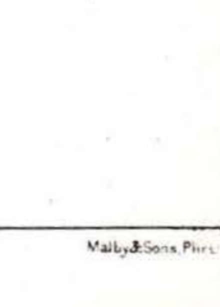
Fig. 13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4'
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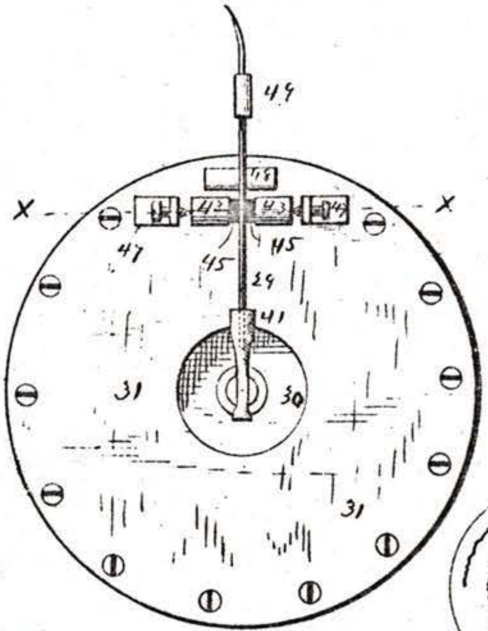
16

A.D. 1887. Nov. 8. Nº 15,232.
BERLINER'S COMPLETE SPECIFICATION.
(4th Edition)

(3 SHEETS)
SHEET 3.

[This Drawing is a full-size reproduction of the Original.]

Fig. 9.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X
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Fig. 16

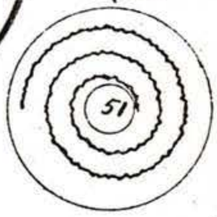

Fig. 15

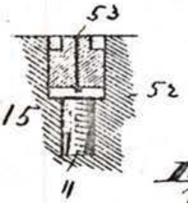

Fig. 11

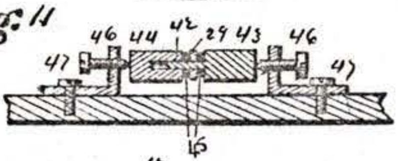
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Fig. 14

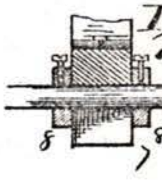
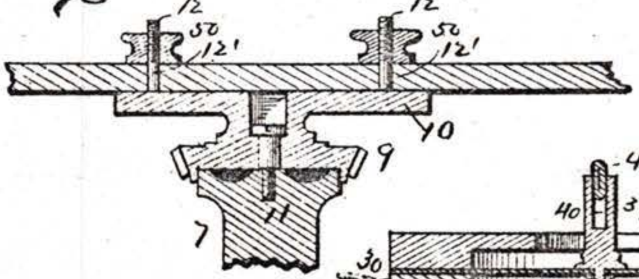


Fig. 12.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12'
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12'
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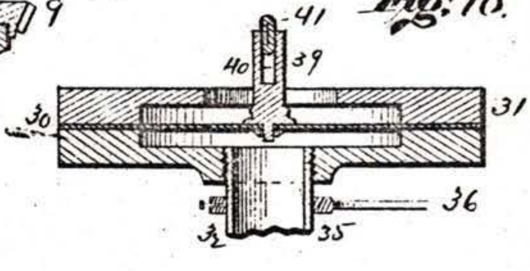
11

Fig. 10.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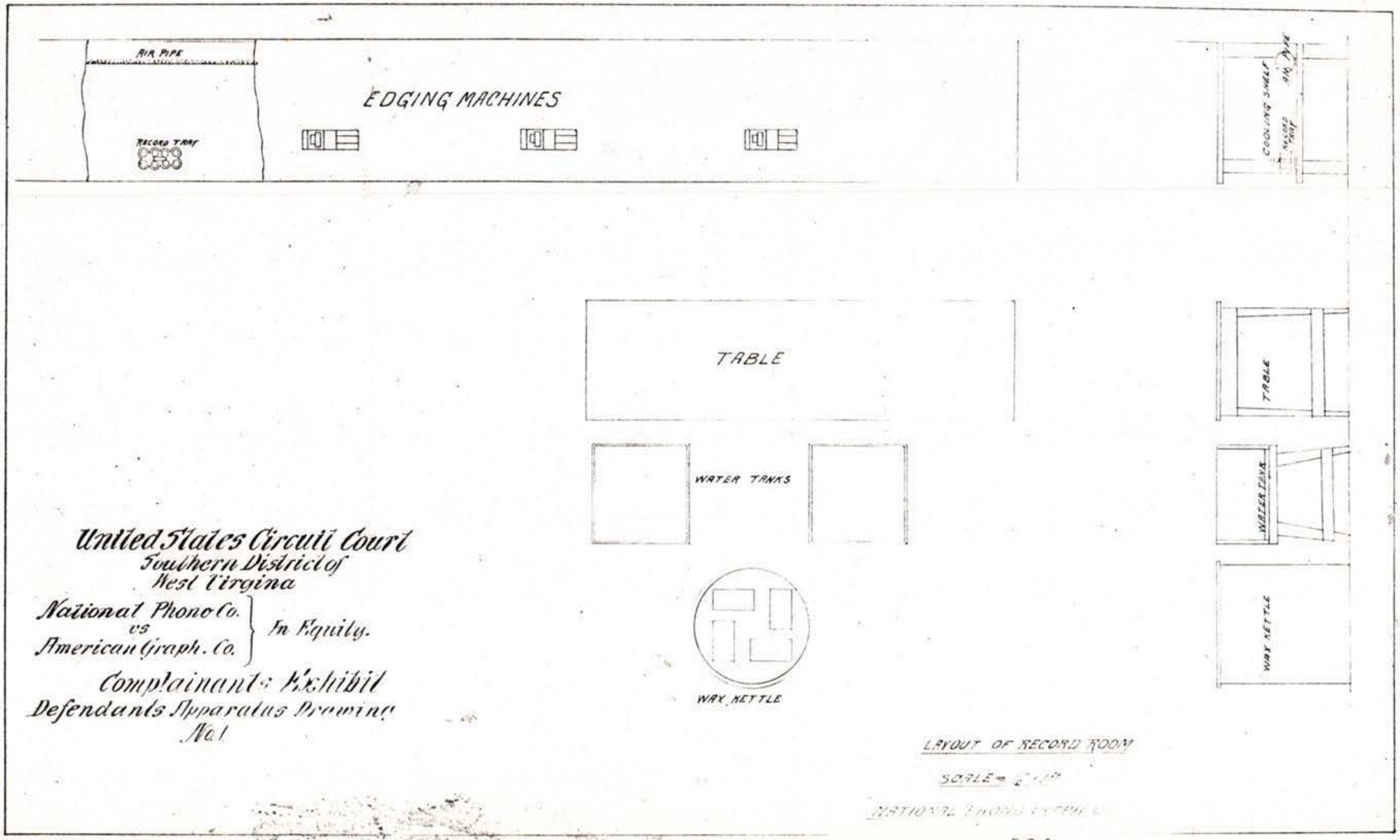
Malby & Sons. Photo Litho.



AIR PIPE
RECORD TRAY
EDGING MACHINES
COOLING SHELF
AIR PIPE
RECORD TRAY
TABLE
TABLE
WATER TANKS
WATER TANK
WAX KETTLE
WAX KETTLE

United States Circuit Court
Southern District of
West Virgina

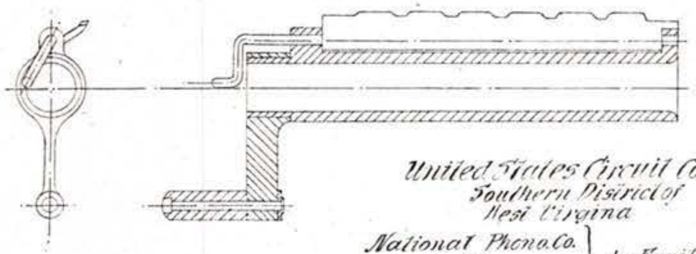
National Phono Co.
vs
American Graph. Co.
In Equity.

Complainants Exhibit
Defendants Apparatus Drawing
No 1

LAYOUT OF RECORD ROOM

SCALE = ½" = 1'

NATIONAL PHONOGRAPH CO.

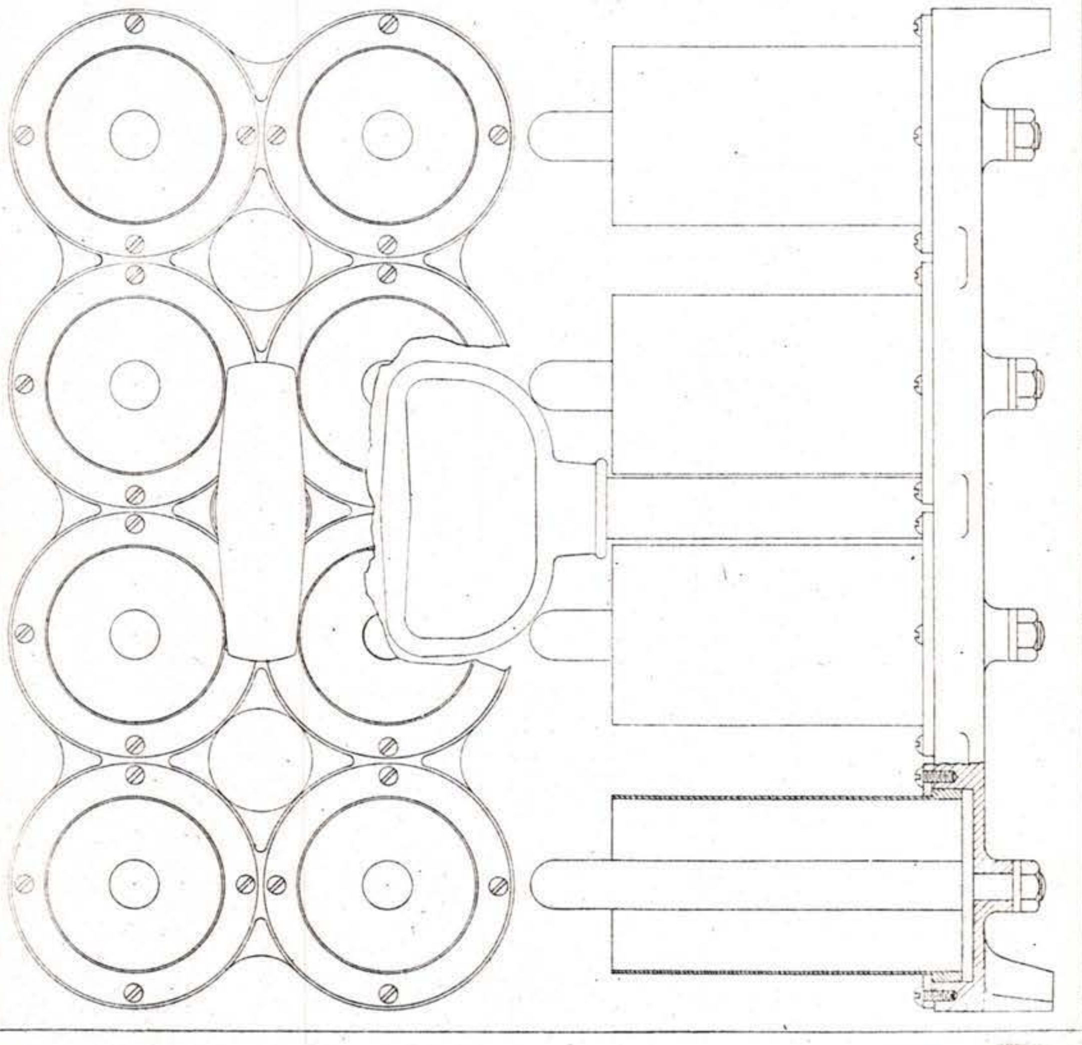


United States Circuit Court
Southern District of
West Virgina

National Phono. Co.
vs.
American Graph. Co. } In Equity.

Complainants Exhibit
Defendants Apparatus Drawing
No. I

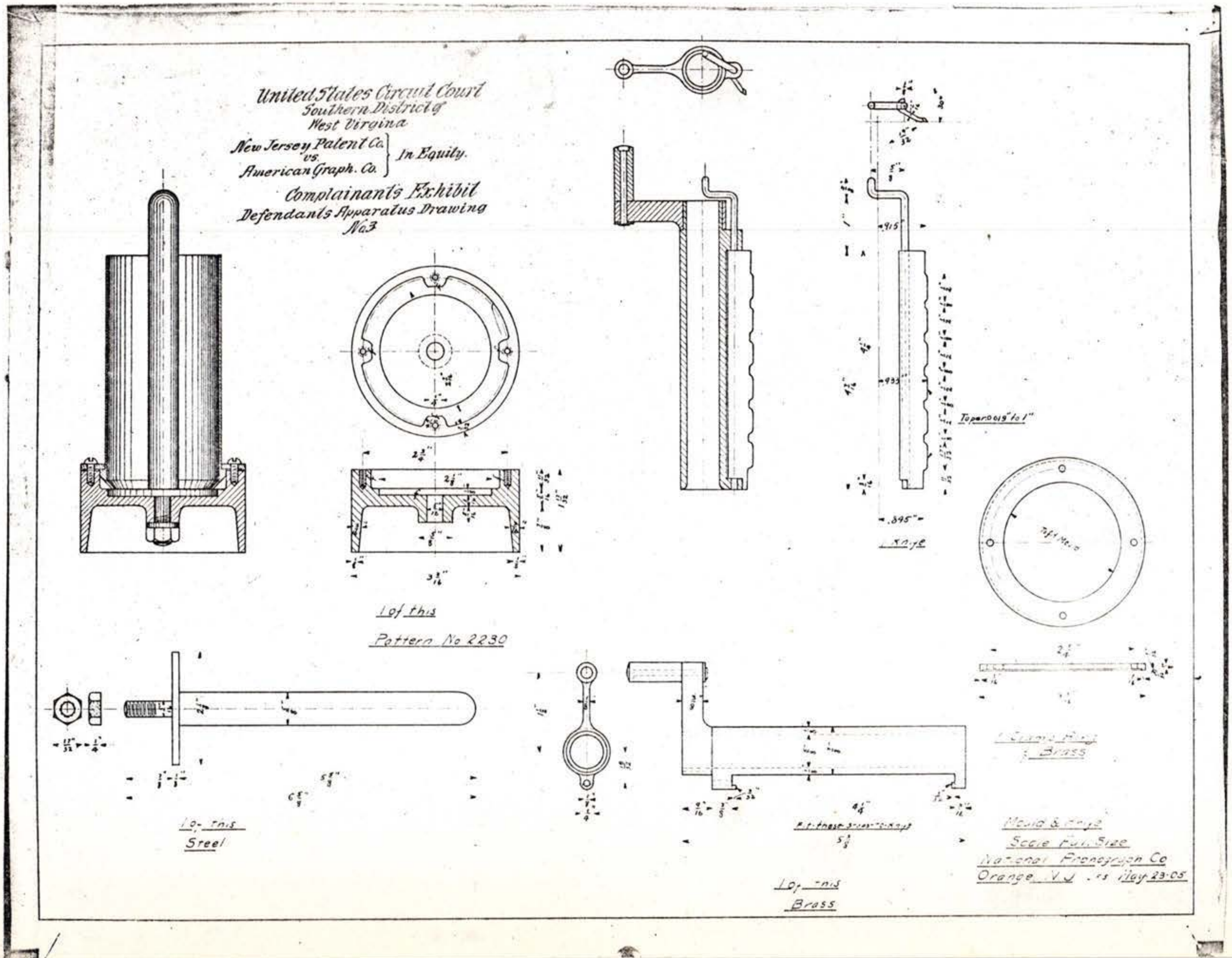
MOULD AND KNIFE FOR RECORD MOULDING
NATIONAL PHONOGRAPH COMPANY
ORANGE, N.J. SEPT. 27-05.



United States Circuit Court
Southern District of
West Virgina

New Jersey Patent Co.
vs.
American Graph. Co. } In Equity.

Complainant's Exhibit
Defendants Apparatus Drawing
No. 3

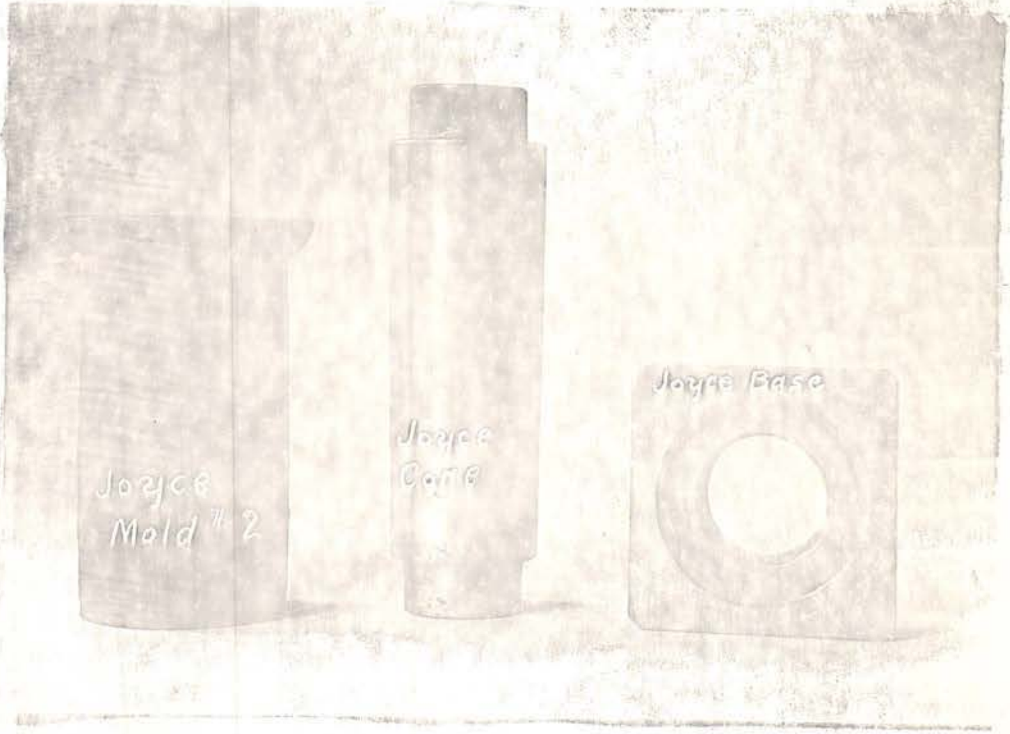


1 of this
Pattern No 2230
.915"
.935"
.895"
Taper 0.015" to 1"
Knife
Top of Mould
1 of this
Steel
Fit these screws to Knife
1 of this
Brass
1 Clamp Ring
1 Brass
Mould & Knife
Scale Full Size
National Phonograph Co
Orange N.J. May 23-05

UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 615.
NATIONAL PHONOGRAPH CO. VS AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 676.
NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 891, 668.

Complainants' Exhibit - Photograph of Joyce
Original Mold, Core and Base.



UNITED STATES CIRCUIT COURT,
SOUTHERN DISTRICT OF WEST VIRGINIA,

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 615.
NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 676.
NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 831, 668.

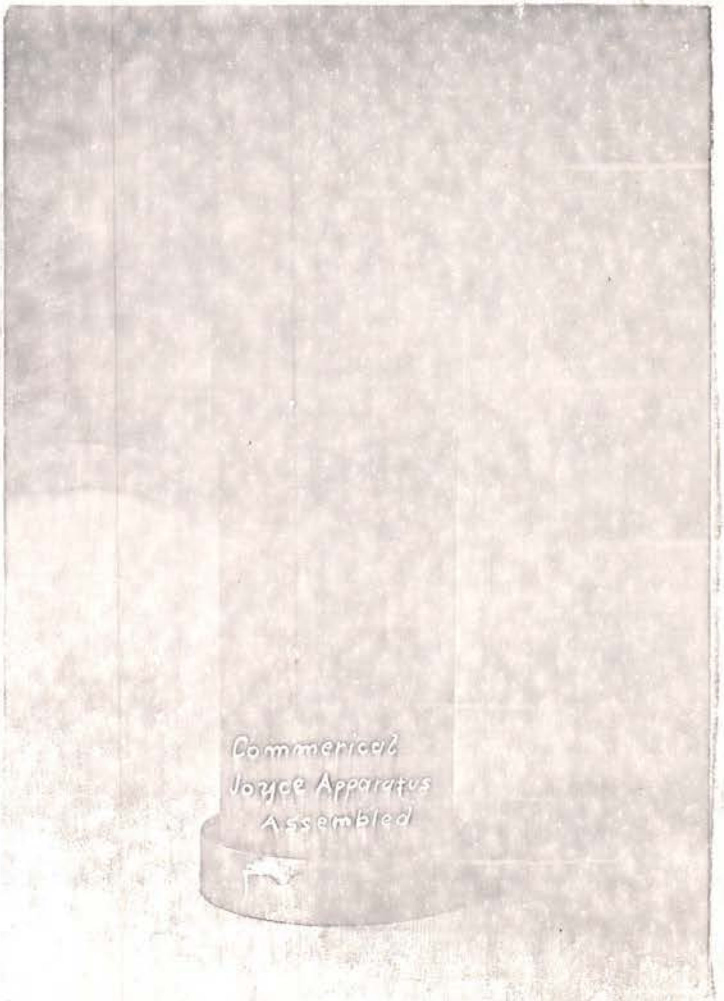
Complainants' Exhibit - Photograph of Commercial
Joyce Apparatus Unassembled.

Commerical Joyce
Apparatus unassembled

UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 615.
NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 683, 676.
NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 831, 666.

Complainants' Exhibit - Photograph of Commercial Joyce Apparatus Assembled.



UNITED STATES CIRCUIT COURT.

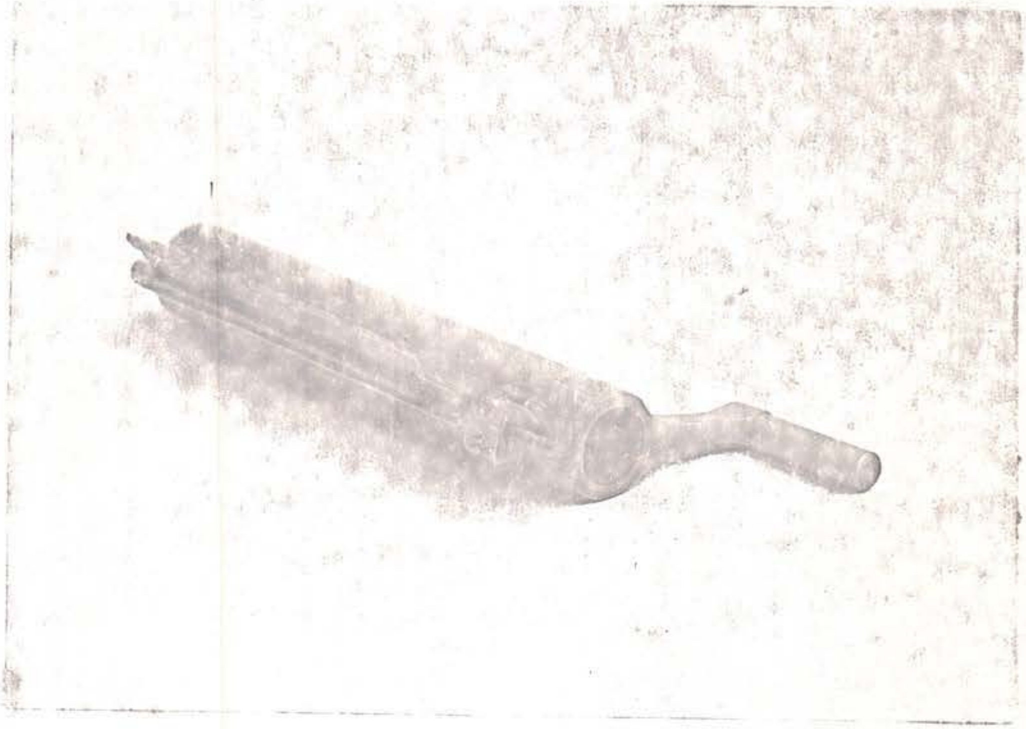
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO.
VS.
AMERICAN GRAPHOPHONE CO.
IN EQUITY ON LETTERS PATENT
NO. 683, 615.

NATIONAL PHONOGRAPH CO.
VS.
AMERICAN GRAPHOPHONE CO.
IN EQUITY ON LETTERS PATENT
NO. 683, 676.

NEW JERSEY PATENT CO.
VS.
AMERICAN GRAPHOPHONE CO.
IN EQUITY ON LETTERS PATENT
NO. 681, 668.

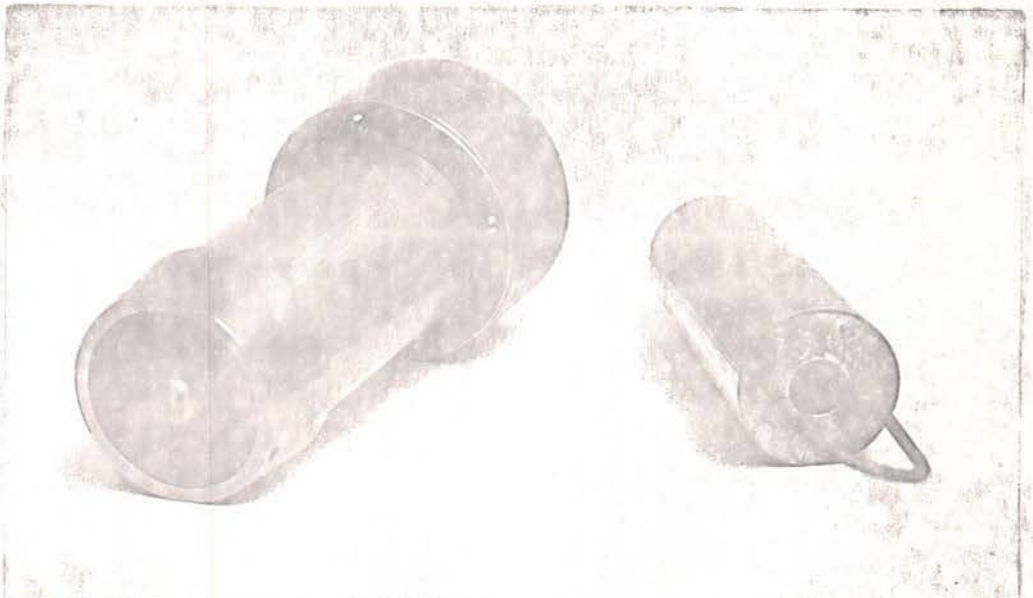
Complainants' Exhibit Photograph of Weber's Reproduction of Defendants' Reaming Tool.



UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN [illegible] ON LETTERS PATENT NO. [illegible], 615.
NATIONAL PHONOGRAPH CO. VS. AMERICAN GRAPHOPHONE CO.	IN [illegible] LETTERS PATENT [illegible], 676.
NEW JERSEY PATENT CO. VS. AMERICAN GRAPHOPHONE CO.	IN EQUITY ON LETTERS PATENT NO. 651. 668.

Complainants' Exhibit, Photograph of Weber's Reproduction of Defendants' Mold and Core Unassembled.



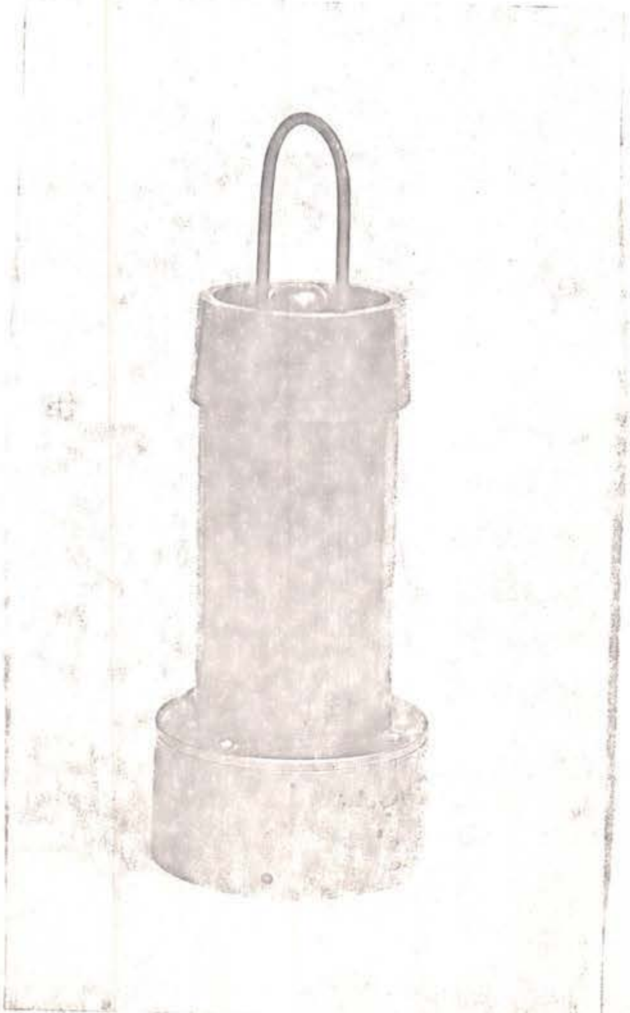
[illegible] COURT.
[illegible] VIRGINIA,

[illegible] ENT

[illegible] LETTERS PATENT
[illegible] 683, [illegible]

NEW JERSEY [illegible]
vs.
AMERICAN GRAPHOPHONE CO. } [illegible] ON LETTERS PATENT
NO. 831, 668.

Complainants' Exhibit, Photograph of Weber's Reproduction of Defendant's Mold and Core Assembled.



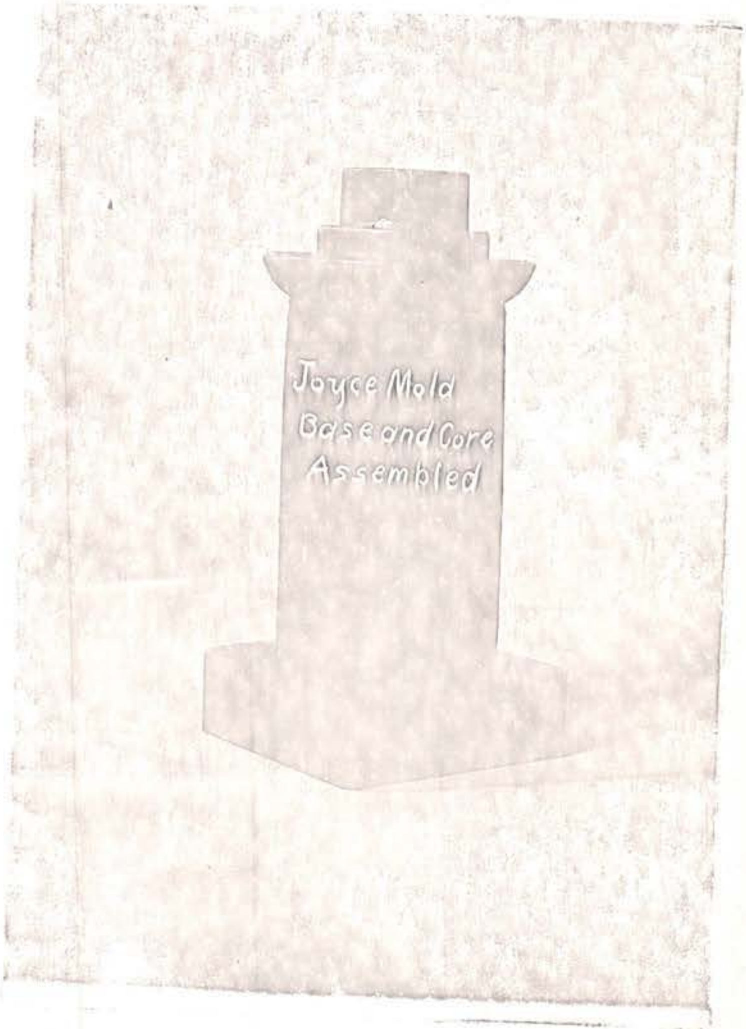
UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL PHONOGRAPH CO.
VS.
AMERICAN GRAPHOPHONE CO.
} IN EQUITY ON LETTERS PATENT
No. 683, 615.

NATIONAL PHONOGRAPH CO.
VS.
AMERICAN GRAPHOPHONE CO.
} IN EQUITY ON LETTERS PATENT
NO. 683, 676.

NEW JERSEY PATENT CO.
VS.
AMERICAN GRAPHOPHONE CO.
} IN EQUITY ON LETTERS PATENT
NO. 831, 669.

Complainants' Exhibit - Photograph of Joyce Mold, Base and Core Assembled.



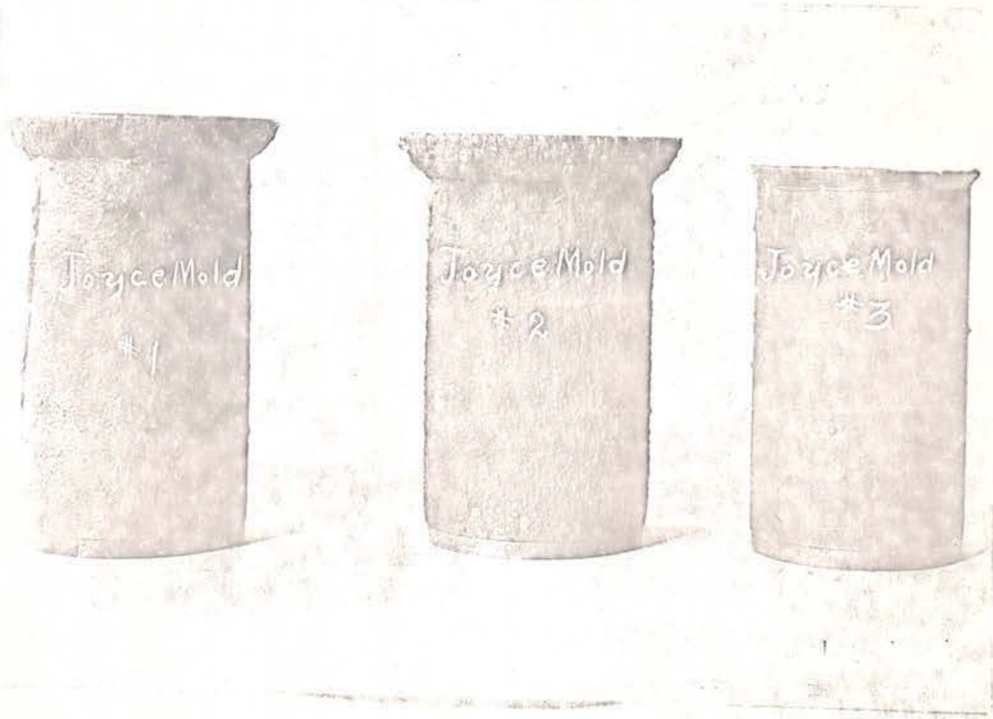
UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF WEST VIRGINIA.

NATIONAL [illegible] [illegible] FOR LETTERS PATENT
[illegible] [illegible] 683 [illegible]

[illegible] FOR LETTERS PATENT
[illegible] [illegible] 83, 570

NEW [illegible]
vs.
AMERICAN [illegible] [illegible] FOR LETTERS PATENT
NO. 331, 668.

Complainants' Exhibit - Photograph of Joyce Molds.


Joyce Mold
#1
Joyce Mold
#2
Joyce Mold
#3

Original volume also included pages 353-368.
These were blank and did not contain exhibits.

R. R. Wile 1/2/74.